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Extracts from "Researches as to Lime-burning. By M. Petot, *Engineer of Roads and Bridges.* Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

Article xvii.—*On the preparation of Factitious Puzzolanas, and particularly of that afforded by Gneiss Sand.*

§1. *On different kinds of Puzzolana.*

The important part that puzzolanas play in the improvement of hydraulic mortars, sufficiently explains the interest that belongs to an examination of this subject. As yet we know of no other means of forming mortars susceptible of hardening in water: and even since hydraulic limes have become the subject of particular study, that of puzzolanas has not been the less attended to, because hydraulic limes are not to be found in every locality, nor is it always possible, or economical, to manufacture them; and because in many circumstances they give mediocre results only, unless mixed with a certain dose of puzzolana.

Puzzolanas may be arranged in two principal classes, namely, natural puzzolanas, and artificial puzzolanas. Among the first, the most energetic are, generally, volcanic matters of a composition analogous to clays. These were discovered first in Italy, where their use goes back to time immemorial. Afterwards they were found in countries possessing extinct volcanoes, as Auvergne, Vivarais, Guadeloupe, &c. The matters which furnished them have sustained, by igneous action, a change in the primitive mode of combination in their elements; but as the intensity of this action was not every where the same, there resulted products of various degrees of cohesion: and it is not difficult to conceive that great differences may exist in their qualities, although none may exist in their chemical composition.

It may, nevertheless, be possible that a puzzolana is no more than of medium quality, merely because, as is said in common parlance, it is still *too*

*Paris, from the Royal press, 1833.

young. In cases where there was at first too much cohesion, certain influences may, in the course of time, bring about a state of disaggregation. This phenomenon is not without example in nature: the greater part of the feldspathic rocks are in these circumstances, and produce a second variety of puzzolanas. Such, particularly, are the graywackes of Carhaix, the arenes of Perigord, and our gneiss sands. The geological position of these substances, at least of the gneiss which we have before us at Brest, does not admit the supposition of any igneous action. This disaggregation goes on little by little, and we take, as it were, nature in the act, for between the upper parts of the quarries which are in a state of sand, and those which are still in the condition of hard rocks, it is not rare to find a series of layers of every intermediate grade of cohesion.

These recent puzzolanas are but slightly energetic: but by torrifying them, they are rendered, if not equal to the first, at least applicable to almost all the same uses: they thereby pass into the class of artificial puzzolanas.

In the same class we must also arrange, after they have been highly calcined, compact schists, and even basalts. Calcination was, in fact, the means applied to these substances by M. Gratien Lepère, and the Swedish engineer Baggé. Lastly, all clays, considered either as proceeding from the decomposition of rocks, or as forming particular earths, lead to the same result by the application of heat.

Few localities are without clays; whence the general use, from very remote periods, of the dust of bricks or tiles, as cement. We may now substitute, with economy, the sands of graywacke, of gneiss, and of arenes; but these latter substances are less common. By their use the subject does not change its aspect; there is merely an enlargement of its boundaries.

In all puzzolanas, natural or factitious, the elements of clay, namely, silex and alumine, determine the hydraulic qualities: moreover, silex alone, in jelly, or lightly calcined, but in a state of extreme division, gives, by its mixture with fat lime, a good hydraulic mortar; while it is not the same with alumine; we may, therefore, say, definitively, that silex is the base of all puzzolanas; and that, reciprocally, all substances containing silex in a state of feeble cohesion are apt to become puzzolanas.

§2. *On several methods employed in the preparation of Factitious Puzzolanas.*

The study of the quality and use of natural puzzolanas not having immediate connexion with the question before us, we shall restrict our remarks to artificial puzzolanas. And we shall first refer to the several methods applied to their preparation.

The material to which recourse is had, may be submitted to heat, first, in the state of powder; and second, in the state of fragments, either brick shaped, or of irregular forms. In the first case, all refractory, ochreous, or calcareous, clays may afford good puzzolanas by a torrefaction of a few minutes. It will be sufficient to spread the powder in a thin layer on an iron plate, and keep it incandescent from five to twenty-five minutes. M. Vicat, to whom we are indebted for the knowledge of this method, adds, however, that it has not been applied on a large scale, and that it offers some difficulties. M. Girard de Caudembourg assures us, from his own experiments, that when the arene sands have been lightly torrefied, the time required to set under water is shortened, but the hardness of the mortars is not increased. This consequence, founded on a particular case of calci-

nation, does not prove that it is true in general of arenes, more than of graywacke or gneiss.

In the second case the materials are employed either pure, that is to say, in the state nature supplies them, or previously mixed with certain substances designed to facilitate the chemical reaction. This premised, we see, according to Gen. Treussart, that calcareous clay brought to the same degree of calcination as lightly burned bricks, gives good results; and that from this degree up to that of the highest calcination, its energy rapidly diminishes, and at last becomes null; that for ochreous clays, on the contrary, the calcination of lightly burned bricks gives very mediocre results; but that these results are progressively ameliorated up to the degree of burning required to produce good bricks, beyond which it decreases indefinitely; that, lastly, refractory clays also give excellent puzzolanas at the degree of burning which makes good bricks, but they resist better than the ochreous clays the effect of a higher calcination, and do not sensibly lose quality up to a calcination equalling that of common lime. It is, consequently, to be supposed that they attain their maximum less quickly; and such is, without doubt, the reason why Chaptal—submitting to the same mode of calcination refractory clay, sometimes pure, and sometimes mixed with the sulphate of iron, which gave the equivalent of an ochreous clay, found different results, and concluded that the oxide of iron was an element essential, generally, to the success of the operation.

Clays, at the same time ochreous and calcareous, but containing at least a tenth of their weight of lime, like clays simply calcareous, require only a slight calcination. (Treussart.) We may thus, by a slight burning, obtain good puzzolana with an ochreous clay, by impregnating it with a certain quantity of lime, according to the recommendation of Inspector General Bruyère. We might also, with equal success, replace the lime by potash or soda; and such, for example, is what is called *aquafortis cement*, a residue left in the preparation, by means of clay and nitrate of potash, of nitric acid.

At the works on the canal from Nantes to Brest, graywacke, in irregular pieces, was submitted to a degree of heat like that required to furnish good bricks. And, according to M. Vicat, blue schist requires to be heated till it swells up, (*boursoufle*,) and basalt till it melts, (*le basalt doit couler.*)

For the burning of all these materials in fragments, lime kilns or brick kilns may be used. Unfortunately, the uniformity of the burning not being perfect in any of these kilns, fragments are mixed together, some of which are too much, and some too little, burned; and, consequently, there is a mixture of good and bad puzzolana, affording a mediocre result, or at least a result quite inferior to what may be obtained in the laboratory.

If to this be added, the expense necessary to pulverize and sift these same fragments, it will be perceived how important it is to be able to apply on a large scale M. Vicat's method; for with that method nothing is easier than to arrive at a uniform degree of calcination; after which the products need no manipulation. Such was the object in view in constructing the furnace described below. The abundance of the gneiss sand in the quarries of the port of Brest enabled us to avoid the expense of a preliminary pulverization, and at the same time we were enabled to turn to profit the immense quantity of wood chips furnished by the naval constructions.

Note. Then follows in the original:

Description of a furnace for factitious puzzolanas.

Details relative to the various parts of the furnace.
Progress of burning.
Quantity of products obtained.

The furnace being a reverberatory, the cement was spread out upon the hearth in undulating zones, rather thicker near the front than in the rear, or on the sides, and the aperture was closed for twenty to twenty-five minutes. At the end of this time the surface submitted to the flame was renewed, by turning over the substance. Waiting about another twenty minutes, the calcination was sufficient, and the matter was drawn away to give place immediately to another portion. The author then proceeds:

The quantity of puzzolana prepared in this way varied as the furnace was more or less hot; but it became constant after the fifth or sixth day, and amounted regularly to 120 cubic feet in 24 hours. The number of burnings in the same interval was 34; which gave for each burning 3.53 cubic feet of puzzolana and 42 minutes of time.

The first days the furnace was in operation, we withdrew as much as 177 cubic feet in 24 hours. But experience was not slow in demonstrating that too much in quantity was injurious to the quality; and, which is remarkable, this imperfectly burned sand was less energetic than the crude sand. It was not less important to prove, on the other hand, what would happen in prolonging the calcination beyond 42 minutes. To this end, two new essays were made, the one with two hours', and the other with three hours' burning; and we found that under these circumstances, the energy of the puzzolana suffered a little as respects the rapidity of the setting, but remained about the same, as to resistance to rupture, at the end of fifteen months.

It was important to have, as a term of comparison, some trials of the gneiss burned in the state of fragments, according to the process antecedently used. For that purpose we took, at hazard, a considerable stock of powder reduced from fragments burned during twelve to fifteen hours in a lime kiln; and other powder reduced from fragments burned above the lime, in another lime kiln. With the first, the results were inferior to those with the crude sand; with the second, they were sensibly better than the crude sand, but weaker, notwithstanding, than the sand calcined in the reverberatory furnace.

§3. *Comparative experiments with the Puzzolana of Gneiss, taken in different conditions.*

The experiments here mentioned are united in the two following tables.

Table No. XLIII.—*First series of experiments.*

No.	Composition of the mortars.	Time required to set.	Resistance to rupture per 0.394 inch (centimetre) square.	Age of the mortars when broken.	Remarks.
		d's.	lbs.	mo's.	
1	One of lime in paste with two of crude gneiss sand .	20	2.35	8	Immersed in sea-water. The time of setting, a little uncertain on account of the surface swelling up.
2	Same with two and a half .	20	3.23	do.	
3	Same with two of sand slightly calcined . .	35	2.04	do.	
4	Same with one of sand do. and one of quartzose sand	?	<0.77	do.	The resistances to rupture were calculated generally after the formula of Galileo, $2\,Pc = R\,a\,b^2$ wherein P indicates the weight that caused the rupture; c the distance of the point of supportof the mortar to the point of application of the load; a, the breadth of the prism, and b, its depth.
5	Same with two and a half of gneiss sand calcined for 42 minutes . .	7	5.37	do.	
6	Same with two do. . .	7½	5.37	do.	
7	Same with one and a half do.	8	4.03	do.	
8	Same with one do. and one of quartzose sand .	20	<0.99	do.	
9	Same with two of pulverised fragments having been heated from twelve to fifteen hours in a lime kiln .	34	2.11	do.	
10	Same with one and a half of the same puzzolana .	?	<0.97	do.	
11	Same with one of do. and one of quartzose sand .	?	<0.75	do.	
12	Same with two of pulverized fragments heated more highly than the above .	8	3.43	do.	All the mortars comprised in this table were immediately immersed in sea water.
13	Same with two of do. from another fragment, .	7	4.69	do.	

Table No. XLIV.—*Second series of experiments.*

No.	Composition of the mortars.	Time required to set.	Resistance to rupture per 0.394 inch (centimetre) square.	Age of the mortar when broken.	Remarks.
		d's.	lbs.	m's	
14	One of lime in paste with two of gneiss sand calcined for forty-two minutes	8	5.19	15	Tempered stiff and immersed immediately in fresh water.
15	Same with two of sand calcined during two hours	12	5.70	do	
16	Same with two of sand calcined during three hours	20	5.76	do	
17	Like No. 14, but tempered very soft and immersed immediately in fresh water	24	3.04	do	

Table No. XLIV—Continued.

No.	Composition of the mortars.	Time required to set	Resistance to rupture per 0.394 inch (centimetre) square.	Age of the mortar when broken.	Remarks.
			lbs.	mo's	
18	Like No. 15 but a little less soft than No. 17	16	8.96	15	
19	Like No. 16 and about the same consistence as No. 18	20	4.70	do.	
20	Like No. 14 but allowed to dry for 18 hours before the immersion	12	6.60	do.	It is remarkable that under fresh water the mortars have not the same tendency to swell up as in sea-water.
21	Like No. 15 and with the same precaution as No. 20	11	7.17	do.	
22	Like No. 16 and with the same precaution as Nos. 20 and 21 . . .	13	6.60	do.	

§4. *On the influence of the inert portions of gneiss sand.*

The trials Nos. 4, 8 and 11 indicate that the puzzolana of gneiss will not bear any addition of quartzose sand: all the other numbers indicate that when calcined properly it gives mortars that set very soon under salt water or fresh water, but that it acquires in the end, only a moderate hardness. In fact, it can be arranged only in the class of puzzolanas *simply energetic.*

All these results appear to us to be affected by one and the same cause, the presence of inert matter. We know that gneiss, like granite, is formed of quartz in grains, mica and feldspar: but the quartz totally resists spontaneous decomposition; the mica resists it in part, because it is that substance which is seen in the sand of the quarry in countless brilliant spangles: the feldspar alone undergoes chemical alteration, and furnishes the active element of puzzolana. The energy of this puzzolana depends then on the relative quantities of feldspar on the one hand, and of quartz and mica on the other. Several attempts at a separation have given us a mean proportion of about one quarter for the quartz. The mica is much more abundant but difficult to separate. On collecting, by means of a very fine seive, the most pulverulent portions of a well burned sand, it appeared to be extremely charged with mica; and on tempering it with lime in paste, it gave a mortar which did not indurate in water till the end of 24 days; while with the same sand not sifted, the setting of the mortar occurred at the end of the 7th day.

We will add that the proportions of constituents may vary, from one quarry to another, or even in different veins of the same quarry. It was thus, probably, that on one occasion, the calcined sand, taken at hazard from the store house, gave us—*time of setting, five days—resistance to rupture per* 0.394 *inch, (centimetre) square*—11.22 *lbs.—age of the mortar when broken* $5\frac{1}{2}$ *months.*

The energy of the products obtained from the reverberatory furnace ap-

pears then to depend quite as much on the substance used as on the degree of calcination given to it.

§5. *Trials of the same reverberatory furnace in the calcination of plastic clays.*

What we have thus far said of the gneiss sand is applicable, for the greater part, we do not doubt, to graywacke sands and to arenes; but circumstances have not permitted us to verify it.

Plastic clays have the advantage of these feldspathic rocks, in not being mixed with matter essentially inert; in this respect they offer more chances of being converted into very energetic puzzolanas. But can they be treated with success in the reverberatory furnace? We wish to clear up this question, by some trials, of which we will proceed to give an account.

We made use of the common clay of Brest, which is ochreous and eminently plastic. After having cut it into small slices by means of a wire, and having dried these little slices in the air, they were reduced to powder, or rather they were ground, in an apparatus, of which a description would be useless at this time, but which may be said to be founded on the same principle as a *coffee-mill.* The clay brought to this state was introduced into the furnace, as the gneiss sand had been, and was heated with the same kind of fuel, first for forty-two minutes, then for two hours, and afterward for three hours. We had thus three kinds of puzzolana, which, used in the fabrication of mortars, gave:

The 1*st. an imperfect hardening--a tendency to form paste with water;*

The 2*nd. hardened in twenty days—resistance to rupture after fifteen months,* 3.17 *lbs;*

The 3*rd, hardened in eleven days, resistance to rupture after fifteen months,* 6.86 *lbs.*

At the same time we found:

That with puzzolana from well burned square tiles, the hardening took place in 7 *days; and the resistance to rupture, after eight months, was* 14.30 *lbs: that with puzzolana from Italy, the hardening took place in seven days, and the resistance to rupture, after eight months was* 16.35 *lbs.*

Whence we see that the degree of heat afforded by our reverberatory furnace is insufficient to give to plastic clays all the energy of which they are susceptible. It might be otherwise if we were to use a better fuel: but it is not the less demonstrated that, as regards calcination, we cannot place gneiss sands and plastic clays in the same list. As to these last, one consideration is striking; which is, that if the calcination be not perfectly uniform, all those portions which retain a tendency to form paste with water, will become an obstacle to the setting of the mortar, and a permanent cause of alteration. The gneiss sands, on the contrary, act even in their natural state, like puzzolana; and, in the most unfavourable case, give a mixture of portions, only more or less active.

§6. *On calcination on a small scale, upon thin iron plates.*

The results we have just been exposing do not at all conform to the manner in which the preparation of factitious puzzolanas, by heating pulverulent substances on plates of sheet iron, has been considered. *An incandescence for a few minutes—a very moderate burning,* compared to what is required in the burning of lime on a large scale, or even in the burning of bricks, carries with it the idea of a degree of heat easy to attain; and, con-

sequently, of the necessity of a particular influence exerted by the contact of atmospheric air. It will not, therefore, be without interest to rectify this opinion by new experiments, which, besides, lead to some other remarks.

On exposing iron plates to the fire in a common fire place, the degree of heat obtained is too feeble: for the clay in powder, heated in this way during 10, 20, 30, 45, and 60 minutes, gave a puzzolana still forming paste with water, excepting the last, which was passible. Under the same circumstances, limestone reduced to powder, did not lose beyond 6 or 8 per cent. of its weight. In order to obtain greater heat, and to operate with more promptitude, we placed plates of sheet iron in a small forge over a fire of charcoal, we then found, for 100 grammes of powdered hydraulic limestone containing 33 per cent. of carbonic acid, duration of calcination—10 minutes—15 minutes—20 minutes—45 minutes: corresponding loss of weight —8.33 gms.—30.00 gms.—32.85 gms.—33.00 gms.

The last three specimens, sprinkled with water, slaked and swelled like ordinary lime just from the kiln. In a few minutes, therefore, the same effects are produced by ignition on a plate of sheet iron, as after several days of burning in a kiln.

To ascertain what would happen on replacing the powdered limestone by powdered clay, we made two series of experiments, one on gneiss sand, and the other on an ochreous clay: mortars were made of the resulting puzzolanas; and we deduced from the experiments the two following tables.

Table XLV. *Gneiss Sand.*

Duration of the calcination.	0	3½′	5′	7½′	10′	15′	20′	40′	60′	120′	B. It was not always possible to ascertain exactly the loss of weight, on account of the adherence of the sand to the iron.
Loss of weight on 100 grammes		gms. 6.20	g. 6.30	g. ?	g. 7.30	g. ?	g. 7.15	g. ?	g. ?	g. ?	
Order in which the hardening under water occurred	4	3	1	1	1	2	3	4	5	5	The hardness was measured by the weight necessary to force into the mortar a wire 0.047 of an inch in diameter.
Hardness after two months.	Soft and without consistence	gms. 400	g. 800	g. 800	g. 800	g 800	g. 500	g. 300	g. 250	g. 180	

Table No. XLVI. *Powdered ochreous clay.*

Duration of the calcination.	5′	7′	10′	15′	20′	25′	30′	40′	60′	120	The first two specimens were heated more violently than common. The clay adhered to the sheet-iron.
Loss of weight on 100 grammes.	?	?	gms. 9.50	g. 9.65	g. 1160	g. ?	g. 12.20	g. 12.50	g. ?	g. ?	
Order in which the hardening under water occurred	4	3	3	2	1	1	2	4	5	6	All the puzzolanas mentioned in these two tables, were of a decided red, except the first, which had the natural colour of the sand.
Hardness after 2 months.	gs. 900	g. 1000	g. 1000	g. 1100	g. 1500	g. 1500	g. 1200	g. 600	g. 500	g. 200	

These tables show that the degree of heat necessary to convert ochreous clay into good puzzolana differs but little from that necessary to the complete calcination of lime, and may, consequently, be assimilated to that required to produce good bricks: that for the gneiss sand, as we have already shown, a much lighter calcination will suffice, and which, on a large scale, should not exceed the calcination given to slightly burned bricks. Nothing as yet shows the truth of the hypothesis, that the contact of the air exercises a particular influence on the calcination of any argillaceous substances whatever, on plates of iron. It is objected, it is true, that the same substances calcined in close vessels do not give the same results; but there is nothing in that which should surprise us, as we will attempt to prove.

§7. *On calcination in Close Vessels.*

We operated in a melting furnace with crucibles of about $4\frac{1}{4}$ quarts: instead, however, of four hours' fire required for melting trass, we limited our fire to two hours. The first crucible containing gneiss sand, contained, besides, several small fragments of hydraulic limestone, weighing about $\frac{1}{3}$ of a pound each, and so disposed, that after the exposure to the fire, we could ascertain, by their aid, as by a pyrometer, the relative intensities of the heat in different parts of the mass. We here see what happened.

1st. In the high and central parts of the crucible, the gneiss sand neither changed colour nor consistence: and the calcareous pieces lost only five or six hundredths of their weight.

2nd. In the enveloping layer, the sand, slightly agglutinated, had taken a pale gray slate colour; and the calcareous pieces, rather more burned than the preceding, gave a pellicle of lime which slaked in contact with the air.

3rd. In the more exterior layer, the sand had the consistence of the scoria of forges, and a decided slate colour. The calcareous fragments were found in the state of perfect lime, but without any indication of supercalcination, or any adherence to the matter surrounding them.

A second crucible, filled with ochreous clay, in powder, which had been dried at a low red heat, gave products altogether analogous; that is to say, gave three distinct species: one of the ordinary red colour, another of a deep purple, and a third of a slate colour.

In the transition from one to the other of these principal products, there necessarily existed a great many shades, difficult, certainly, to isolate, but which did not the less correspond to so many particular degrees of calcination. We may then conclude,

1st. That it is nearly impossible to obtain a homogeneous torrefaction in close vessels.

2nd. That if the substances employed are ochreous, their fusibility will manifest itself at a degree of heat less than that which is necessary for the calcination of lime; which does not happen when in contact with the air on plates of iron.

3rd. That consequently, in these two modes of preparation of puzzolana, the same degrees of heat do not correspond to the same chemical reaction.

4th. That, therefore, not having any thing but the appearance of the substances, to guide us in the choice of terms of comparison, we are liable to oppose to the best puzzolana prepared in contact with the air, another prepared in a close vessel, in which the chemical reaction of the elements

is in a very different state of advancement: and this, whether the clay were ochreous, or simply composed of silex and alumine.

Thus then, as has been already seen, it might happen that two mortars made of different puzzolanas, would acquire, after a certain time, the same hardness without having had, nevertheless, the same promptness of induration. Thus we may say, further, that the variable proportion of alumine soluble in hydrochloric acid, is not a consequence of such or such a mode of calcination, but rather of the difficulty of seizing terms of comparison perfectly exact.

§8. *On the decrease of the energy of Puzzolanas as they approach the point of vitrification.*

The phenomena which will be developed in the following article, taught us the importance of ascertaining whether the diminution in the energy of puzzolanas was progressive as the substances approached the term of vitrification. With this view we collected the preceding puzzolanas, prepared in close vessels, and bearing traces more or less evident, of vitrification. Making mortars of these, we remarked in the first place, that a very small addition of water sufficed to soften them in a singular manner. Be that as it may, the specimens obtained in stiff paste, were immersed the same day; the others were not immersed till the next day, in order to give them time to dry. After fifteen days none of them had acquired any kind of consistence; all being merely inert matter. With time, these results might change, no doubt, but they will not be the less inferior to those of §6.*

If, instead of substances containing the oxide of iron, we had employed those containing lime, potash, or soda, it may be presumed it would have been the same; because the substances we have named all act as fluxes with silex. Thus, therefore, in whatever manner the solidification of mortars may be explained, it is necessary to admit, that puzzolanas require to be deprived of water by heat, and not to have too great cohesion given to them. Whence it results that the most proper degree of calcination cannot be the same for all puzzolanas, but should vary, more or less, according as the substance employed contains more or less water, and a flux more or less energetic.

§9. *The relation between the quality of Puzzolanas and some of their physical properties.*

In indicating the conditions necessary to obtain good puzzolanas, M. Vicat says, (*Résumé sur les mortiers*, page 33,) that the matter ought to have the minimum of specific gravity, and the maximum of absorbent power. If this were rigorously true, it would be an argument against the hypothesis of a chemical reaction in the solidification of puzzolana mortars. We believed it would be interesting to verify this opinion; and to that end, we made the several experiments exhibited in the following tables.

*After a month, these mortars had not improved perceptibly. The specimens made of the puzzolana the most highly calcined were as soft as on the first day. Au.

Table No. XLVII.

Gneiss sand, in several states of calcination.	Weight of substance submitted to experiment.	Weight of substance after 18 days' exposure in a dry place.	Weight of substance after 3 days' exposure in a humid place.	Weight of substance after 7 days' exposure in a humid place.	Maximum increase of weight for 100 parts of the substance.
	Grms.	Grms.	Grms.	Grms.	Grms.
Crude sand highly dried . .	41.90	42·00	42.30	42.30	0.95
Calcined for 3½ minutes . . .	35.75	35.83	36.05	36.05	0.84
Do. 5 do. . . .	35.50	35.60	35.80	35.80	0.84
Do. 7½ do. . . .	36.00	36.10	36.30	36.29	0.83
Do. 10 do. . . .	34.50	34.60	34.75	34.75	0.72
Do. 15 do. . . .	33.75	33.86	34.05	34.04	0.80
Do. 20 do. . . .	34.70	34.80	34.96	34.95	0.75
Do. 40 do. . . .	32.45	32.54	32.67	32.65	0.61
Do. 60 do. . . .	32.30	32.39	32.52	32.50	0.68
Do. 120 do. . . .	30.25	30.44	30.55	30.55	0.66
Calcined in a close vessel, a little melted, (un peu frittée) . . .	55.00		55.20	55.15	0.36
Do. do. more melted	51.70		51.80	51.75	0.20
Do. do. still more melted	49.90		50.00	50.00	0.20

Table No. XLVIII.

Ochreous clay in several states of calcination.	Weight of substance submitted to experiment.	Weight of substance after 18 days' exposure in a dry place.	Weight of substance after 3 days' exposure in a humid place.	Same after 7 days' exposure.	Same after 3 days' exposure	Maximum increase of weight for 100 parts of the substance.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Calcined during 5 minutes .	26.55	26.59	26.85	26·95	26.94	1.50
Do. 7 do. .	27.00	27.17	27.45	27.54	27.54	2.00
Do. 10 do. .	32·45	32.49	32.90	33.05	33.04	1.85
Do. 15 do. .	32.15	32.20	32.65	32.74	32.72	1.77
Do. 20 do. .	29.20	29.22	29.58	29.63	29.65	1.52
Do. 25 do. .	31·70	31.75	32.03	32.12	32.15	1.40
Do. 30 do. .	29.65	29.70	29.95	30.03	30.05	1.33
Do. 40 do. .	29.25	29.26	29.50	29.57	29.57	1.08
Do. 60 do. .	36.70	36.74	37.05	37.20	37.20	1.36
Do. 120 do. .	19.00	19.04	19.20	19.25	19.25	1.31
Calcined in a close vessel, a little melted, (un peu frittée) .	54.65		54.74	54.80	54.76	0.27
Do. do. more calcined	55.40		55.53	55.60	55.50	0.36

These two tables show, 1st, that puzzolanas exposed in a dry place have a very weak absorbent power; 2d, that this absorbent power augments, in a very sensible manner, in a wet place, a circumstance which renders the condensation of gas, admitted by some persons, but little probable; 3d, that this power is at its maximum before the gneiss sand or the clay had acquired the most advantageous degree of calcination; 4th, that it is not equal, by a considerable difference, in the two kinds of puzzolana, and in this respect it gives a tolerably correct idea of the relative energies; 5th, and lastly, that the vapour of water thus condensed does not enter into

combination with the fixed matter, for it escapes, though in a small quantity, by a simple hygrometric variation in the atmosphere.

Experiments show that in taking bricks in several states of calcination, and immersing them in water, the proportion of liquid absorbed is greater for bricks but slightly burned, than for bricks more burned; that is to say, it is greater for bricks which give only a mediocre puzzolana, than for those which give a good puzzolana. The same experiments will also show that dry clay, before reaching the term of good burning, augments its volume in passing through the term of half burning; and that in this last state, the density of the brick is less than in the preceding. The maximum of energy, therefore, neither corresponds to the maximum of density, nor to the maximum of absorbent power.

ARTICLE XVIII.—*On the Preparation—the Preservation—and the Use of Plastic Cements.*

§10. *On Lime Stones which serve for the preparation of Plastic Cements.*

When a lime stone contains about twenty per cent., or more, of its weight of clay, it may furnish the substance known under the names of *plastic cement—Parker's cement—Roman cement.* This substance has the property of hardening very soon, like plaster of Paris; but it has also the further property of indurating under water, like the hydraulic limes. These plastic cements present characters so peculiar, in their preparation and in their use—they have, besides, acquired so high an interest in France since the creation of the establishment of Pouilly, that we have thought proper to appropriate to them a special article, the better to insist on several observations of which the importance will be easily seen.

Until within a few years, plastic cement was a production exclusively English. It was principally near the Thames that the stone, proper for its fabrication, was found. In 1802, similar stone was found on the sea shore, at Boulogne, but in rolled pebbles, and in too small quantity to become an object of regular preparation. It exists also at Baye, near Nevers, according to M. Vicat; in Russia, according to Messrs. Lamé and Clappeyron, and, no doubt, in many other localities; but up to the present time the researches of M. Lacordaire, at Pouilly, are the only ones which have produced very positive results, on a large scale, in France.

The stone from which the English cement is derived, appertains to the upper steps of the secondary, lias formation. It is ordinarily found in rounded masses in the middle of marley strata. That of Pouilly appertains to the same geological formation: such a coincidence leads us to conclude that this kind of formation is most favourable to new investigations. However that may be, the following are analyses of plastic cements already known:

English cement—carbonic acid deducted	55.4	of lime,	44.6	of clay.
Cement of Boulogne pebbles	54.0	do.	46.0	do.
Pouilly cement—first variety	42.86	do.	57.14	do.
The same—second do.	36.37	do.	63.63	do.
Russian cement	62.00	do.	38.00	do.
Cement of Baye	21.62	do.	78.38	do.

§11. *Mode of preparation followed by Parker.*

It was in 1796 that Parker first indicated the means of converting into cement, the very argillaceous lime stones found in roundish masses, and called *septaria.* His process consisted, essentially, in pushing the calcination of the stone to vitrification: and he took out, for his process, a patent in which are the following details:

"The stones are first broken into small fragments: then burned in a kiln as is commonly done with lime, at a heat sufficient to vitrify them; afterward reduced to powder by a mechanical or other operation. The powder thus obtained is the base of the cement. To compose this cement in the most advantageous manner, two parts of water are mixed with five parts of powder, and stirred and beaten to effect a mixture. The cement thus made ought to set or harden in ten or twenty minutes either in air or in water." (Extract of a report of M. Mallet to the *Société d'Encouragement.*)

Parker not having succeeded in his enterprise, and his process having been abandoned, it was generally supposed that he was mistaken, founding the opinion on what happens with fat lime too highly calcined. But here analogy fails, as we shall soon show by experiment.

§12. *Mode of preparation followed by the successors of Parker.*

The plastic cement which now circulates in trade should not be designated by the name of Parker's cement, for there is a capital difference in the preparation. We are ignorant whether the successors of Parker have given a description of their process; but it is easy to judge of the means by the end. Their cement, in fact, treated with muriatic acid, causes a notable quantity of carbonic acid gas to escape. It has besides an ochreous colour resembling that of the natural stone, and differing much from that which may be given it by vitrification. There is no doubt, therefore, that the cement is formed of the septaria *incompletely calcined.*

As to the method followed by M. Lacordaire, M. Mallet, at page 12 of the report already cited, says:

"The stone is explored by blasting with powder in pits and galleries, at a mean depth of about 262 feet. The selection of stone is made above ground, where it is broken into pieces the size of the fist, and carried to the kiln, which is of the kind called *fours contans ou à feu continu* (continual fire.) The stone, when burned and brought to the state of lime, is ground under a pair of cast iron cylinders weighing about 5300 lbs. . . . . The cement is afterwards passed through sieves formed of iron wire separated 0.06 of an inch; by this first operation, a cement is obtained which is called No. 2. This is then passed through a bolting machine also formed of iron wire, but with finer meshes; and it is then called No. 1."

M. Mallet no where says that the cement is incompletely calcined; but it would be a mistake to suppose otherwise. It is, besides, easy to prove it; for the cement tried with acids, permits, as in the English cement, a notable quantity of carbonic acid to escape.

§13. *As to what occurs to Plastic Cements at the point of complete calcination.*

We see from what precedes, that it is equally possible to obtain plastic cements by super-calcination and by incomplete calcination.* But the

*The existence, at the same time, of two means of preparing plastic cement, and the obscurity in which the method of Parker remained, has occasioned more than one mis-

fact most worthy of remark is, that at the point of *complete calcination*, not only the stone does not slake, but if it be treated like ordinary cement, it gives a substance nearly inert. All this is the reverse of fat lime; and it is impossible to confound one substance with the other.

This instant of inertia of plastic cements, between the points of incomplete calcination and supercalcination, seems to us a capital fact in the study of the substances. It explains how a suitable lime stone might escape discovery and be rejected as unsuitable, from a simple fault of calcination, which would not be a fault with fat lime, or with hydraulic lime. In this category we may cite the trials of Gen. Treussart of the Boulogne pebbles. He calcined the stone in the middle of the common lime in an Alsace lime kiln: he was thus led to anomalies which we now easily comprehend.

Note. The author then refers to Nos. 1, 4, 6, 7, 9, *and* 12, *of table No. VIII, of the preceding work of Gen. Treussart.* (*Jour. Frank. Ins. Vol. XX, p.* 320.)

M. Vicat, effecting the calcination by the same means, no doubt, found that the cement of Baye did not harden till after three days' immersion. This would not be a long time for hydraulic lime, but it is unreasonably long for a plastic cement, which the Baye lime stone, from its composition, may be considered to be. The proportion of clay is so great in this cement, that we think it must contain a notable quantity of silex in grains; otherwise, it does not comprise a larger proportion of lime than the artificial mixtures of M. Bruyère, and like them would afford only a puzzolana and not a plastic cement.

§14. *Experiments on the English Cement, and on the English Cement Stone.*

We will now detail the experiments that have led us to a knowledge of these alternations of good and bad quality in plastic cements—beginning with the English cement.

1st. The English stone that we had at command was of a yellowish colour, and very compact texture. After having broken it into small pieces, and placed it in a crucible, we heated it in a laboratory furnace furnished with its dome, up to the complete disengagement of the carbonic acid—as proved by pieces taken from the upper part of the crucible. But owing to the inequality of calcination in a vertical direction, a great number of fragments were found, agglutinated, fritty, and blackened. They were separated with care, and gave by trituration, a powder of blackish gray. Not knowing, at that time, the process of Parker, we thought that all the supercalcined stone must be good for nothing: and it was only to acquire a direct proof thereof that we tempered this powder with water. After a few minutes, to our surprise, the first specimen had hardened. A second specimen prepared and put under water, showed that the induration was comple in less than fifteen minutes.

take. M. Hassenfratz, for example, says in his treatise on mortars, page 195, "The calcination of this stone (Boulogne pebbles) is the same as that of ordinary lime; if it is too much heated, it vitrifies and is no longer proper for making cement." And further on (page 197) he adds, "At London they calcine, in conical furnaces with a central fire of sea coal, the lime stone of which they make Roman cement: but the management of the fire demands much attention, because when the heat is not properly adjusted, the cement sustains an incipient fusion, and is no longer proper for any use." He had, notwithstanding, said (p. 126) that the Boulogne pebbles, strongly calcined, and for a long time, gave a lime which hardens easily, and that this hardening became equal to that of stone, at least; but when it is only calcined to the same degree as fat lime, the cement does not harden with the same facility, nor so much. AUTHOR.

All the stone that was in the upper part of the crucible had escaped any sensible change of colour: pounded and sifted, it was of an earthy yellow; a mortar of stiff clayey consistence was made of it, and immediately placed under water without any envelope. It did not fall to pieces in the water, but, twenty days after, it remained in the same state, that is to say, like a substance wholly inert. A small portion of the same mortar, exposed to the air, had set in one hour and twenty-five minutes, and fifty days after had acquired great hardness.

Another portion of this same yellow powder was mixed with an equal volume of fat lime, to ascertain whether it would act like puzzolana. This mortar, examined for fifteen successive days, comported itself like the unmixed cement; but after about a month, it had set.

2d. The English cement on which we experimented was derived from a stock collected in July, 1824, for the naval works; it had therefore been on hand five years and a half. It was damaged; but we shall show further on that a very feeble heat sufficed to impart much energy to it—causing it to set in fourteen minutes. We filled a crucible with this cement and heated it: the unequal action of the heat enabled us to divide the cement into three portions, in appearance very distinct.

The first part, treated with muriatic acid, liberated no gas; a perceptible change of colour, and a slight agglutination, attested that there had been a commencement of super-calcination. A mortar was made of it, and immediately immersed: The setting was not complete till after six and a half hours.

In the next portion the beginning of super-calcination was more manifest; it should have been triturated and sifted anew, and this operation having been omitted, we think that a diminution of energy was the consequence. However this may have been, after its immersion the edges crumbled off, but the setting was complete in three hours and forty minutes.

Lastly, the third portion, which was from the bottom of the crucible, was *fritty* and *drossy;* it gave a powder of a slate blue colour. A little of it was made into mortar, and made to fill the bottom of a glass: this being put under water appeared hard in thirty-three minutes. A second larger specimen was immersed, not being supported on the sides: the edges did not crumble in the least, and at the end of forty-eight minutes it had well set.

§15. *Similar experiments with the Pouilly Cement.*

Not having the Pouilly cement at command, we were not able to operate throughout as in the other case: but this circumstance need not, we think, be much regretted, since the cement in powder, with which we were supplied, still retained much carbonic acid, and would enable us to ascertain, equally, the effects of complete calcination and of super-calcination.

The Pouilly cement, revived by a new calcination of a few minutes, like the English cement, sets in the air in five minutes. A crucible filled with cement, already deteriorated, was calcined in a heat not very great: cement taken from the top of the crucible, had not lost its carbonic acid, and set under water in eight minutes and a half: the remainder was divided into two specimens which indurated in the air, one in eleven minutes, and the other in sixteen minutes. These cements, at the moment of setting, disengaged heat in a remarkable manner.

Another crucible filled with the same, having been heated more violently, the first portions of powder, tested by muriatic acid, retained hardly any traces of gas; they afforded a mortar, which, exposed to the air, disengaged

a little heat, and hardened in thirty-six minutes. At this moment it was immersed, but soon split to pieces, softened, and preserved its consistency only in a few places. After fifty days, it was found totally reduced, and decomposed into friable lumps.

The remainder of the contents of the crucible was divided into two portions. The first, containing much that was agglutinated, required to be pulverized again; it gave a mortar that hardened in the air in twenty-one minutes, and preserved its form, well, after immersion. The second, completely converted into scoria, became, in powder, of a blue purple: converted into mortar, it hardened in the air in twenty-six minutes, and did not lose its consistency in water.

§16. *Indications, touching the preceding experiments, given by the proof of Rupture.*

It became interesting to complete these experiments, trying the proof, or test, of rupture; and such is the object of the following table: but we have some previous observations to make.

Plastic cements acquire a strong consistence in a short time. For example, the experiments of M. Leroux at Cherbourg, reported in the memoir of M. Mallet already quoted, were made after about fifty days, and gave very satisfactory results. We have operated with a shorter interval; but it is possible that two mortars may be equal at the end of the year, and not at any briefer period, especially when one is immersed, the other exposed to the air, and when the volumes are very small. But we could not avoid this last inconvenience, because, from being obliged to separate the products into several portions, the bulk of each particular kind was necessarily small. For each specimen we never had more than fifteen cubic inches of mortar: the numbers that we are to submit must therefore be received with caution, and only as stating the hydraulic qualities of the substances.

Table No. XLIX.

No.	Substances employed.	Time required to harden.	Resistance to rupture per 0.394 inch (centimetre) square.	Age of the mortars.	Observations.
			lbs.	Days.	
1	English stone completely decarbonated			20	Could not be tested.
2	The same stone, with fat lime		1.10	50	Immersed.
3	The same, super-calcined	15′ in water.	6.39	50	Do.
4	English stone, carbonated	14′ in the air.	15.75	35	Exposed to the air.
5	The same	14′ in water.	7.24	35	Immersed.
6	The same reburnt up to super-calcination	6 h. and 30′			Put in a glass.
7	The same, super-calcinated more strongly	3 h. and 40′	2.69	35	Immersed.
8	The same, super-calcinated to the state of scoriæ	48′	5.17	36	Do.
9	Pouilly cement carbonated	5′ in the air.	3.46	34	Do.
10	Do.	16′	1.93	34	Do.
11	Do.	11′	4.22	34	Do.
12	The same, completely decarbonated	36′ in the air.		30	Fell to pieces under water.
13	The same, perceptibly fritty	21 in water.	19.07	34	Immersed.
14	The same, in scoriæ	26′	3.15	34	Do.

§17. *On the alteration of Plastic Cements.*

The English cement delivered at the Port of Brest, in 1824, was preserved in well closed barrels: that which came to us from Pouilly was in a double cask, with an interval of about two inches filled with absorbent powder of common lime or powdered charcoal: this last method is very expensive no doubt, but it is preferable to the first, when the cement is to remain a long time in store. Whatever may be the process, however, the substance, whether it retains a portion of carbonic acid, or has been super-calcinated, will always lose part of its energy.

In fact, the English cement, which in the first place, set under water in twenty-two minutes, required twenty-one hours to set, after it was five years old, without the barrels having been opened or exposed in any humid place. The Pouilly cement which may be made so energetic as to harden in the air in five minutes, required forty-eight minutes as a mean term of the several trials to which we submitted it, after being four months in store. Further, the barrel having been first opened, and then closed less exactly, sufficed to cause the outside layers of cement to afford a mortar the edges of which crumbled under water, and which had not hardened at the end of four hours.

As to the super-calcined cement, that which would harden, in the first instance, in fifteen minutes, was so altered by thirty-nine days' exposure to the air, that it had acquired only a half-consistence during three days that we successively examined it.

Under such circumstances, we may easily see that the mortars are not susceptible of acquiring great hardness. It is true that the diminution in this respect, is not proportioned to the diminution in the energy of setting; but it does not the less follow, that those plastic cements of which the use is deferred, lose the quality the most characteristic, if not the most precious; and that notwithstanding the precaution used in barreling the substance, the evil can only be retarded. Connected with this, if we consider the liability to negligence in the process of calcination and pulverization, we can comprehend how it is that the use of plastic cements has fallen more than once into disfavor; why the manufacturers have been accused of mixing inert matter with their products in order to augment the bulk; and why the great price of these substances, joined to the uncertainty as to their qualities, has deterred many constructors from their use.

§18. *On the chemical phenomenon that accompany the alteration of Plastic Cements.*

We were at first of opinion, from such considerations as are above stated, that it would be preferable to export, instead of the cement, the cement stone before calcination, as is done with plaster of Paris. An augmentation of weight of twenty or thirty per cent. might be compensated by the suppression of the barreling and all other means of preservation. But although we might act thus in certain places, we could not in all places: and there would be no guarantee that the best mode of preparation would be followed every where; or that the quantity of cement needed, would be worth the trouble of calcination.

Examining then, what occurs in the alteration of plastic cements, we in the first place, ascertained that the super-calcined cement, when exposed to the air for thirty-nine days, had absorbed carbonic acid, and we concluded, *a fortiori*, it would be the same with the cement incompletely calcined, because the combination of lime and clay does not, therein, take so much

cohesion; but we have not been able to satisfy ourselves that this gas, often found in cement the quality of which is good, should be hurtful when found under other circumstances; we have considered, as much more probable, that its presence is indifferent in all cases; and that the cements were good only because the lime and the elements of the clay existed therein in a proper state of combination.

We ascertained, afterward, that cements, while they enjoy all their energy, are not soluble in water; or at least the oxalate of ammonia gives to the water in which they have been immersed, scarcely the lightest cloud. The deteriorated cements, on the contrary, give a precipitate quite abundant, and susceptible of being collected.

We noticed, lastly, that the super-calcined cement and the Pouilly cement, which are of a deep colour, become whiter as they deteriorate; and the white parts give to the water in which they are immersed, a cream which is incapable of solidifying.

From these indications we have concluded that the deterioration of cements is accompanied by a chemical disunion between the lime and the clay composing them; that no doubt the lapse of time between the preparation and the use of the cement, may permit a spontaneous decomposition, but that water, either alone or aided by carbonic acid, is the most active cause; and that we may, therefore, restore to these elements all their primitive energy, by submitting them to a new calcination sufficient to drive off the absorbed water, and re-establish the combination between the lime and the clay.

These are the theoretic inductions which determined our researches as to the possibility of making use of damaged cements. Experience has fully confirmed them, as will be seen in due time.

§19. *On the revivification of deteriorated cements.*

Pouilly cement that hardened in the air in twenty three minutes was heated to a low red heat during twenty five minutes, on a plate of iron. After this operation, being tested with muriatic acid, it showed the presence of carbonic acid, as before: converted into mortar it became hot and solidified almost instantly. The setting was perfect in less than five minutes.

Cement of the same kind, heated more violently, and in a crucible, was divided into three portions: the first hardened under water in eight and a half minutes, the second in the air in sixteen minutes, and the third, in eleven minutes. All three, tried by muriatic acid, disengaged much carbonic acid.

English cement, setting under water in twenty one hours, was made red hot on a plate of iron for twenty eight minutes: this operation did not deprive it of its carbonic acid: tempered and immersed, it hardened in thirty-one minutes.

Cement of the same kind heated for about one hour was divided into two parts: the first, retaining still a little carbonic acid, hardened in the air in fourteen minutes, and the second, which was nearly in the same state, hardened under water in fourteen minutes.

English cement supercalcined, exposed to the air during thirty nine days, and which had become incapable of setting under water in two days, was heated on a piece of sheet iron to a red heat for thirty minutes. It retained all the carbonic acid it had absorbed: being tempered and immersed it set completely in thirty-one minutes.

Wishing to apply this operation on a large scale we exposed entire barrels of the deteriorated cement in the reverberatory furnace, in the same way we had exposed the gneiss sand. After this new torrefaction, the English cement which had refused to indurate in less than twenty-one hours, would now set equally hard in twenty-three minutes, at most, either in the air or in the water. In similar circumstances the Pouilly cement which did not harden in less than two or three hours, was brought to give very good results in seven or eight minutes.

There is no doubt then, that at a small expense, and by the aid of a feeble heat, the injury sustained by plastic cements, from remaining too long in store rooms, or exposed in damp places, may be repaired.

§20. *On the recovery of cement mortars already hardened.*

The experiments we have just given caused us to conceive the hope of restoring cements which had hardened after being accidentally moistened and even of restoring mortars themselves. We ascertained that the thing is, in fact possible, but at a much higher temperature.

Mortar made of Pouilly cement, one month old, and already offering a resistance to rupture of about 13 lbs. per 0.394 inch (centimetre) square, was reduced to powder. A portion of this powder made red hot for twenty minutes, gave a mortar which did not become hot and did not harden. Another portion was heated in a crucible for almost one hour: the first layers of cement had visibly changed colour, but had not lost their carbonic acid: they gave a mortar that acted like inert matter. The last layers, on the contrary, were completely decarbonated; a mortar was made of this which increased in temperature sensibly after three minutes' exposure to the air, and hardened after ten minutes; but being then immersed, it split and softened.

Some of the same powder heated more highly in a crucible, and giving some indication of supercalcination, was tempered with water, but, from inadvertency, into too soft a paste. The setting was nevertheless complete after four hours in the air, and it sustained itself well in the water.

Another crucible heated more highly still, gave a mortar which, exposed in the air, took immediately a remarkable consistency; at the end of six minutes, the trial wire gave almost no depression on the surface. There was no heat disengaged at the time of setting.

A last crucible, heated in the same manner, gave also a supercalcined cement which hardened in eight minutes without any disengagement of heat. This specimen and the preceding were immersed immediately; the water did not alter them.

If it be desired to reproduce these results on a large scale, it must not be done in a kiln built to burn puzzolanas, but in a lime kiln; taking care to place the mortar or blocks of hardened cement at the bottom of the charge, in order to obtain the proper degree of supercalcination. We should add, however, that we have not employed this mode of restoration.

§21. *Indications touching the preceding experiments, given by the proof of rupture.*

As in §16, we have united, in the following table, the resistances to rupture of the specimens of mortar of which we have been speaking in the preceding paragraphs.

Table L.

No.	Substances employed.	Time required to harden.	Resistance to rupture per 0.394 in. (centimetre) square.	Age of the mortar.	Remarks.
			lbs.	ds.	
1	Pouilly cement .	23′ in the air	20.25	35	Left in the air.
2	do. restored on a plate of sheet iron .	5′	3.46	34	Immersed.
3	do. do. in a crucible	11′	4.23	34	do.
4	do. do. by supercalcination .	5′	11.53	26	Left in the air.
5	English cement deteriorated	21 hours	3.27	35	Immersed.
6	do. restored on a plate of sheet iron .	31′	4.32	35	do.
7	do. do. in a crucible . .	14′ in the air	15.75	35	Left in the air.
8	do. . .	14′ in the water	7.22	35	Immersed.
9	Mortar restored by supercalcination .	4 hours	3.60	26	do.
10	do. more highly calcined	6′ in the air	4.26	26	do.
11	do. . .	8′	15.26	26	Left in the air.

§22. *Influence of the age of Mortars.*

The two tables we have given of experiments, show a notable difference between mortar immersed and mortar exposed to the air—unfavourable to the former in all cases but No. 13 of the first table. They also show differences between the specimens immersed, which, judging from the time required to harden, were equal in quality. Has the age of the mortar an influence on these results? This we were desirous of ascertaining, at least in part, by some trials which are given in the following table.

Table LI.

No.	Substances employed.	Time required to harden.	Age of the mortar at the first trial.	Resistance to rupture per 0.394 inch (centimetre) square.	Age of the mortar at the second trial.		Resistance to rupture per 0.394 inch (centimetre) square.
			ds.	lbs.	mos.	ds.	lbs.
1	Pouilly cement with one half volume of water. . .	46′	22	7.35	1	19	8.01
2	do. . .	46	27	9.72	4	11	14.36
3	do. . .	51	34	17.70	1	19	16.92
4	do. .	42	42	14.64	4	11	14.71
5	do. . .	52	49	13.03	4	11	24.11
6	do. . .	54	51	15.29	4	11	19.59
7	do. . .	47	60	19.11	4	11	19.76

All these specimens were made, the same day, with cement from the same barrel, tempered with an equal quantity of water, and immersed immediately after the instant of setting in the air; they were all of the size of a common brick. Notwithstanding these similar circumstances, the mortars did not comport in the same manner; and they converged more or less ra-

pidly to the resistance they would have acquired at some future period, as, for example, at the end of one or two years.

§23. *On the mixture of sand and puzzolana with plastic cements.*

Thus far we have employed pure cement, in order to avoid bringing in new cases of irregularity; but it is not less necessary to know to what extent the substances will support a mixture of sands or puzzolanas: and consequently, to know whether it be possible so to add these substances as to have mortars equally good and more economical. With these objects we prepared several specimens which were submitted to rupture after about fifty-four days. This, as has been said above, is no doubt too short a time: but the numbers obtained agree in demonstrating that though sands and puzzolanas, in no way augment the quality of cement-mortars, they may be used without detriment in small proportion; as may be judged by the following table.

Table LII.

Substances employed.		Time required to harden	Age of the mortar at time of trial	Resistances to rupture.
		min.	days.	lbs.
One of Pouilly cement with	one-half of quartzose sand	48	54	14.64
do.	one-half of gneiss sand	43	do.	17.57
do.	one-half of coarse quartzose sand	50	do.	12.31
do.	one-half of Italian puzzolana in gravel	58	do.	14.55
do.	one-half of quartzose sand	44	do.	11.36
do.	one-half of do. and one-half of puzzolana.	57	do.	13.04
do.	one of gneiss sand	47	do.	13.58
do.	one of coarse quartzose sand	1 h. 2 m	do.	9.89
do.	one of puzzolana sifted very fine	49	do.	14.74
do.	one and a half of quartzose sand	47	do.	8.29
do.	one and a half of gneiss sand	1h. 7m.	do.	7.61
do.	two of quartzose sand	1h. 18m.	do.	5.86

As to the ability of these cements to resist frost we have no precise information to impart. We can only say that we applied the process of Mr. Biard to a specimen of pure Pouilly cement which had hardened in the air and was five months old. It deteriorated sensibly from the beginning of the experiment; and at the end of the seventh day we found 1.43 gr. loss from the original weight of 210 grs. Several kinds of bricks tried at the same time, as well as a specimen of mortar made of puzzolana from Italy, did not lose, by a great deal, as large a proportion of their substance. It is to be feared, therefore, that mortar of the Pouilly cement is not frost proof: and this will become a great objection, if, as has been proposed, this cement is used in making casts of moulded objects, statues, bas-reliefs, vases, &c., to be exposed to the ordinary inclemencies of the weather.

§24. *Classification of plastic cements with respect to limes and to puzzolanas.*

As we said in the beginning of this article, the limestones that afford plastic-cements contain a large proportion of clay: larger than hydraulic limestones, and less than calcareous puzzolanas. Establishing then the continued series of combinations which may be formed of pure lime and pure clay, we shall be led, as in the following classification, to three distinct products.

Table LIII.

Lime	Clay.	Resulting products.	Distinctive characters of the products.
100	0	Very fat lime	Incapable of hardening in water.
90	10	Lime a little hydraulic	Will slake, when properly calcined, like pure lime—and will besides harden alone under water.
80	20	do. quite hydraulic	
70	30	do. do.	
60	40	Plastic cement	Will not slake with any degree of calcination—and will harden alone under water.
50	50	do.	
40	60	do.	
30	70	Calcareous puzzolana according to Mr. Bruyére	Will not harden under water without the addition of fat lime or of hydraulic lime.
20	80	do.	
10	90	do.	
0	100	Puzzolana of pure clay	The same.

The distinctive characters given in the table, show, as the proportions vary, the effects of a predominance of lime or clay. But the plastic cements have two maxima of energy, one at the point of incomplete calcination, and the other at the point of supercalcination: do they enjoy this singular property, exclusively? It is important to ascertain this.

1st. Pure lime stone incompletely calcined, slakes with difficulty, and even requires to be pulverised like plastic cement. According to Mr. Minard, if it be tempered with water and immersed, it comports in the beginning like a very energetic substance; and after four days, according to Mr. Vicat, it is impossible to make an impression with the finger. But beyond this, the solidification does not advance.

On the other hand Hassenfratz (at page 203 of his *Traité des mortiers*) says he has noticed that the fat lime of Moustier, supercalcined, gives, after being pulverised and tempered, a mortar which *sets strongly in water*. Mr. Vicat, also, announced in 1818 that common fat lime supercalcined, in contact with a mixture of charcoal and seacoal, became incapable of slaking, and gave, on pulverizing and moistening it, *a paste which hardened under water*.

It is hardly necessary to say that at the term of complete calcination, fat limes are entirely incapable of acquiring, alone, under water, any consistency. However feeble, therefore, may be the hydraulic property of fat lime at the points of incomplete and supercalcination, it is not the less true that it does exist, as in plastic cements.

2nd. Before Mr. Lacordaire had engaged in the Pouilly enterprise described §12, he had ascertained that a limestone but little hydraulic, from which all the carbonic acid had not been expelled by calcination, afforded a true cement; and he applied this observation to profit, in the works of the canal *de Bourgogne*, which he had in charge. With this view he used the ordinary kilns of the country, reducing to three days, the burning which

was commonly extended to six or eight days: he afterwards slaked the lime by immersion, separating the subcarbonated portions, which he incorporated in the mortar, after having reduced them mechanically to powder.

We were of opinion that the common limestone of Pouilly, alternating with the variegated marles, contained, like the marles, the claystone (septaria) of which Parker's cement is made, and that if Mr. Lacordaire preferred extracting these materials by subterranean galleries, rather than by open quarries, it was, no doubt, because he found, below, richer deposits and a better choice of materials. But one of our friends, Mr. Avril, an Engineer, to whom we had communicated our researches, profited by his being at Pouilly to examine this point with much care. He has announced that, in fact, the common limestone of Pouilly properly treated, and retaining about fifteen per cent. of carbonic acid, sets under water in five minutes, and does not yield in any thing to plastic cements; that therefore, the preference accorded to septaria, could not be explained except on the supposition that it was easier, with it, to secure the degree of calcination necessary, and because the limits of greatest energy were more extended. He also discovered that the hydraulic limestone of Pouilly, *suitably supercalcined*, enjoyed the same properties as when in the state of subcarbonate.

Some direct experiments on a few fragments of a hydraulic lime stone from Pompean, *(Ille-et-Vilaine,)* and from Doué *(Maine-et-Loire,)* lead us to believe that these properties are common to all limestones of analogous composition.

3rd. The good puzzolanas produced, on the one hand, by a torrefaction of some minutes on plates of iron, and on the other, by ochreous and refractory bricks, well burned, seem at first to establish two maxima of energy for clays also; but the experiments of the 17th article, (§6 and §7) demonstrated that these two degrees of heat are in fact but one and the same, and that these substances become so much the more inert as the term of vitrification is approached.

As to clays containing at least a tenth of lime, they require, according to M. Treussart, that the degree of calcination should correspond with that of a slightly burned brick; beyond which they become of a quality more and more deteriorated. Is it still the same, at the transition from puzzolanas to plastic cements, when the proportion of lime is from twenty to thirty per cent.? We are unable to say. But it is possible that the influence of lime is then prominent enough to give rise to two maxima of energy.

§25. *Geometrical representation of the influence of Heat on the several compounds of Lime and Clay.*

In order the better to exhibit the influence of heat on the several compounds of clay and lime, we will attempt to represent it geometrically. To do so, let us conceive that from a fixed point two lines are drawn at right angles to each other, of which the horizontal one shall be taken as the axis of the abscissas, and the vertical one, the axis of the ordinates. Then suppose that on the axis of the abscissas we take, from the point of intersection, lengths proportionate to some of the principal degrees of torrefaction; that, for example, we choose for the first the degree of moderate burning of bricks; for the second, the degree of thorough burning of bricks; for the third, the degree of complete calcination of fat lime; and lastly, for the

fourth, the degree of super-calcination of the same lime. If, then, the ordinates be raised on the points of division, and we consider the compounds of lime and clay to be submitted to the corresponding degrees of heat, we might lay off on these ordinates, lengths proportionate to the hydraulic energy of each particular product; and afterward, through the extremities of these lengths, pass a continuous curve, which will be the curve of energy of the compound, whether hydraulic lime, plastic cement, puzzolana, or even fat lime.

In this manner we have constructed the figures 4, 5, 6, 7 and 8, of plate II. Let us go into some particulars respecting them.

1st. Fig. 4 represents the curve of energy of fat lime. This curve has one ordinate null at the abscissa No. 3, which is the term of complete calcination; but at the abscissas 2 and 4, the ordinates have some magnitude, for they correspond to a hydraulic power, feeble it is true, but real.

2d. Fig. 5 represents the curve of energy of hydraulic lime. At the abscissa No. 3, the ordinate will vary much according to the portion of clay contained; but is greater than zero and less than the ordinates Nos. 2 and 4, because on one hand the lime is hydraulic by supposition, and on the other hand we obtain an instantaneous induration, and an improvement in the hardness of mortars, as in plastic cements.

3d. Fig. 6 represents the curve of energy of plastic cements. In some the ordinate No. 3 is nearly null: is it the same in all? we think not. We know in fact that the best hydraulic limes are not those which contain the most clay; that, for example, in the manufacture of artificial hydraulic lime, the proportions of twenty to twenty-five per cent. of clay are recommended as being most suitable. Accordingly, the ordinate No. 3, which is null for fat limes, will augment progressively up to lime containing twenty-five per cent. of clay, then descending in a continuous manner for the limes with thirty per cent. of clay, for the plastic cements with forty, fifty and sixty per cent., finishing by becoming null. We give this explanation as a simple theoretical induction only.

4th. Fig. 7 represents the curve of energy of calcareous clays employed as puzzolanas. The maximum of this curve is at the abscissa No. 1—the term of bricks but little burned. The clays which, from the proportion of lime, approach most nearly to plastic cement, enjoy, perhaps, a second maximum of energy: but we have traced it only by a dotted line.

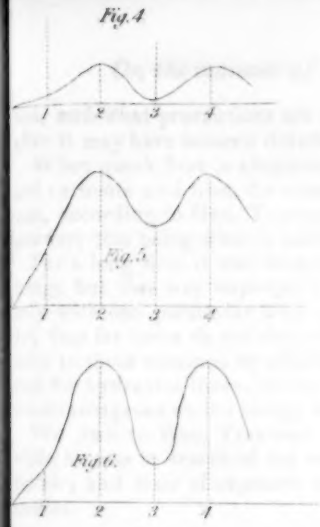
5th. Fig. 8 represents the curve of energy of clays not calcareous. This curve has only one maximum, which is at No. 2—the term of bricks well burned.

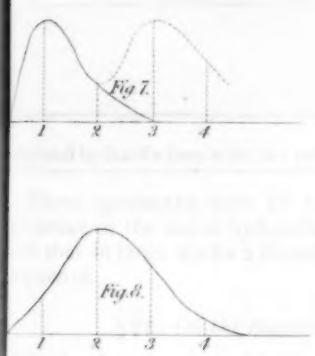
To resume—we see that each of the compounds of lime and clay is characterised by certain properties which vary, more or less, according to the predominance of one or the other of these constituents; that clays have only one maximum of energy, but that limes have two, and that, therefore, plastic cements only offer a particular case of a general phenomenon.

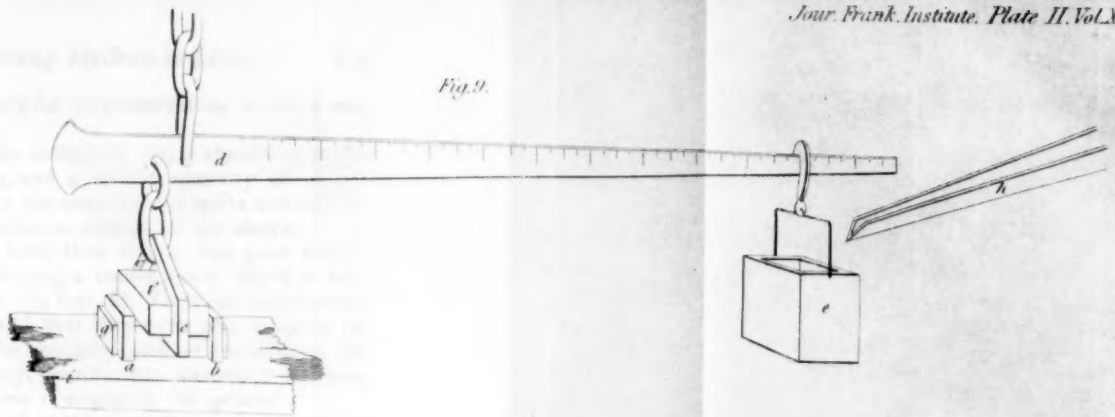
ARTICLE XIX.—*On the change in Hydraulic Limes, and on the solidification of Mortars in general.*

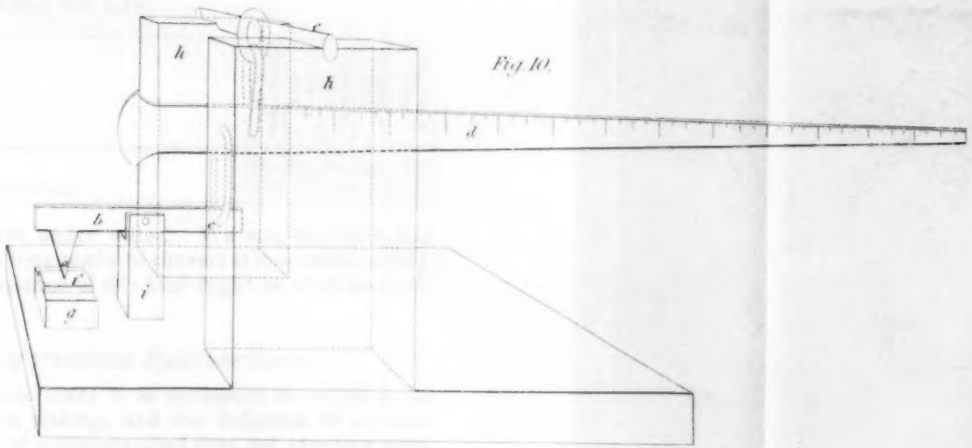
§26. *Influence of spontaneous slaking on Lime in general.*

As lime is not always used immediately on leaving the kiln, it is important to know what modifications time will bring about in its proper-









circulation of air, and the interior parts of the mass will be preserved from its influence.

If this process is not perfect, it is at least economical: and although all the layers of powder which serve as an envelope will be unfit to be used

§26. *Influence of spontaneous slaking on Lime in general.*

As lime is not always used immediately on leaving the kiln, it is important to know what modifications time will bring about in its proper-

ties; and what precautions are necessary for its preservation, or in its use, after it may have become deteriorated.

When quick lime is abandoned to the contact of air, it absorbs moisture and carbonic acid from the atmosphere, and a certain quantity of oxygen also, according to Gen. Treussart. At the same time it splits and falls to powder; this being what is called *spontaneous slaking*, or *air slaking*.

For a long time it was thought that lime thus slaked was good for nothing; but this was improperly generalizing a consequence which is true only with one particular kind of lime. In fact, M. Vicat has ascertained, 1st, that fat limes do not deteriorate, and that they even give superior results to those obtained by slaking in the ordinary mode of immersion: 2d, that for hydraulic limes, on the contrary, spontaneous slaking is the more disadvantageous as the energy of the lime is originally the greater.

We owe to Gen. Treussart the proof of this last observation; obtained while he was in search of the relation between the degrees of alteration in the air; and time of exposure to the air. The following are some of his results.

Table No. LIV.

	Made immediately.	After 15 days.	After 1 month.	After 2 months.	After 3 months.
	lbs.	lbs.	lbs.	lbs.	lbs.
Obernai hydraulic lime with two parts of sand	121	77	44	33	22

These specimens were all kept under water. We see, therefore, that all delay in the use of hydraulic lime tends to convert it into common lime, and that in large works a circumstance of this kind might be of serious consequence.

§ 27. *On the manner of preserving Hydraulic Limes.*

In the deterioration of hydraulic limes it is necessary to consider the influence of the water applied in slaking, and the influence of the contact of air. While the quantity of water absorbed does not exceed a quarter of the weight of lime, this last will remain in dry powder; it cannot solidify; and experience demonstrates that it may then be preserved without change, provided it be carefully covered from the contact of the air, in very tight barrels for example, like plastic cement. But if this powder, which is easily obtained by immersing the lime for twenty or thirty seconds in water, is exposed to the air, it comports nearly as in the case of air slaking; it becomes common lime. At works where there must be large supplies, it is hardly possible, however, to put the lime in casks, because they would be expensive from their number, and embarrassing from their bulk. A middle course remains, which consists in storing the quick lime in very close sheds, and enveloping it, on all sides, with a layer of lime already reduced to powder, in any way: an obstacle will thus be opposed to the circulation of air, and the interior parts of the mass will be preserved from its influence.

If this process is not perfect, it is at least economical: and although all the layers of powder which serve as an envelope will be unfit to be used

as hydraulic lime, it still may be used in a way that will soon be pointed out.

§ 28. *On the use of Puzzolanas in correcting the deterioration of Hydraulic Lime.*

In order to cause fat lime to harden under water, it is mixed with puzzolana; but deteriorated hydraulic limes, as we have said, act like fat lime: if this assimilation be exact, then the same process ought to be applied to both. This is, in fact, what happens; and it is observed that the amount of alteration has no sensible influence on the hardness acquired after about one year. Gen. Treussart was the first who insisted on this important fact; the following are some of his experiments.

Table No. LV.

	Made immediately.	After 1 month.	After 2 months.	After 3 months.	After 4 months.
	lbs.	lbs.	lbs.	lbs.	lbs.
Obernai hydraulic lime slaked spontaneously and mixed with one of sand and one of trass	209	389	352	308	495

Table No. LVI.

	Made immediately.	After 15 days.	After 25 days.	After 35 days.	After 45 days.	After 2 months
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Obernai hydraulic lime slaked by immersion and mixed with one of sand and one of trass . . .	493	330	297	286	304	399

Hydraulic limes employed while fresh, will, according to M. Vicat, support puzzolanas the more advantageously, as the limes are the less energetic; and on the other hand, they deteriorate so much the more rapidly as they are the more energetic: we may thence conclude that if a hydraulic lime has been exposed to any cause of deterioration, it is prudent to mix with it, a certain dose of puzzolana, without any regard to its primitive degree of energy. Artificial hydraulic limes should be treated in the same way.

§ 29. *On the preservation of Puzzolanas.*

As to factitious puzzolanas, it may readily be conceived that their preservation requires but little care, for we know that from their situation in nature, the natural puzzolanas are exposed to all the vicissitudes of the seasons without any apparent loss of energy after a great lapse of time. We will say, however, that a newly made and perfectly dry puzzolana, from its possessing a higher degree of absorbent power, must have a favourable influence on the setting of the mortars. The mortars are often, in fact, tempered too soft; and, to lime already slaked to cream, the workmen add more water to lessen their labour; this excess of water being absorbed in part by the puzzolana, the mortar preserves a strong consistence, favourable to the reaction of its elements. In this respect it is therefore advantageous to keep the puzzolanas in dry situations, or at least if they have been moistened, to dry them in the air, or in the sun, before using them.

§ 30. *On the Solidification of Fat Lime.*

The preparation and the preservation of lime, puzzolana, and plastic cements, are connected so intimately with a knowledge of their properties, that we think it will be useful to add to the indications already given, some developments relative to the theory of mortars in general.*

Proceeding from the simple to the compound, let us explain what relates to common, or fat, lime. When it is plunged into water, it absorbs rapidly, and solidifies, a quantity of water equal nearly to 0.22 of its weight. Withdrawn, then, and left in contact with the air, it slakes with disengagement of heat, and is reduced to dry and impalpable powder. In this state it is capable of absorbing much water still, but without sensible disengagement of heat, and there results a paste more or less stiff. The first portions of the fluid, form, with the lime, a true chemical combination, known by the name of *hydrate of lime:* the other portions of water are, simply, *interposed.* Thus, lime in stiff paste will throw out, on working it, so much water that it is unnecessary to add more on making the mortar. The hydrate of lime, on the other hand, can only be decomposed at a high temperature.

This hydrate being a dry powder, its molecules are too far apart to be able mutually to approach each other, and to pass into the state of a compact mass; it is only after being brought to the state of paste that the hydrate is in a condition to be used. That being premised, it is well known that fat lime, if kept from contact with the air, may be preserved an indefinite time in paste; that this same lime at the ordinary temperature, or at a higher temperature, in paste, or dissolved in water, is without any chemical action on quartzose sand, whether the sand be in fine powder or not; that the mortars which result from the mixture of these two substances, remain soft, like lime alone, as has been ascertained by Dr. John, on examining thick masonry two hundred years old. But if the lime in paste, or the mortar, be left in contact with the air, it will solidify; and if the air be replaced by pure carbonic acid gas, the solidification will take place with great rapidity. In both these last cases the carbonic acid is absorbed by the lime, and this absorption will go on till the acid is to the base, in the ratio, approximately, of 43 to 57, as in the natural subcarbonate of lime. But it is worthy of remark that the proportion of water appropriated to the conversion of lime into a hydrate, is not rejected: the carbonate is not, therefore, *regenerated,* as before the calcination; and it is, in fact, a double salt, which might be called the *hydro-carbonate* of lime.

We see then that for the solidification of fat lime, 1st, the proportion of water must be greater than in the dry hydrate: 2d, there should be contact of the air, or, better still, of pure carbonic acid gas. 3d, the mixture of quartzose sand, without the contact of the air, would not have the least influence. Hence comes the superiority that lime slaked spontaneously, and consequently already somewhat carbonated, imparts to mortars. Hence also the impossibility that these mortars should harden under water, since water, in general, contains only inappreciable quantities of carbonic acid in solution.

The solidification, as Mr. Vicat remarks, spreads from the surface to-

*In a manuscript note communicated to M. Vicat early in 1826, and mentioned in his last work on mortars, we have already stated some of the propositions which follow.
AUTHOR.

wards the centre of the specimen: but the quantity of gas that can pass through the voids of mortar beyond a short distance, is too small for its direct influence to be sensible: if then, there is not a total cessation of absorption, it must be admitted that the transmission must go on by the play of affinities—by the tendency that the several concentric layers of lime have to an equilibrium of saturation, like the transmission of heat in solid bodies. It must also be admitted that the equilibrium is the more difficult to attain, as the parts requiring saturation are more remote from the surface, and the dose of acid already received, is the greater, so that the thickness of mortars is injurious to their solidification: that in equal times, the increase in hardness will be far from being equal, and will progressively become less and less, and, lastly, though it may be exact to say that mortars made of fat lime improve as they grow old, still the improvement may not be at all sensible at the expiration of periods of only a few years each.

§ 31. *On the distinctive characters of Meagre lime and Hydraulic lime.*

Natural limestones often contain earthy or metallic oxides, which by calcination combine with the lime. Whence result modifications in its properties. Thus it is known that lime will remain a fat lime so long as the foreign substances do not form a tenth of its weight; but beyond that it becomes meagre, that is to say, it swells much less on slaking; and, if amongst these foreign bodies, silex should predominate, the paste, with, or without, sand, will acquire the property of hardening in water. It was for a long time thought that other foreign bodies acted like silex; but the method of investigation followed by Mr. Berthier, leaves no doubt in this respect. We will give a summary of his results.

Comparing, first, the quality of various limes with their chemical composition, Mr. Berthier found:

Fat lime from Chateau-Landon to contain 96.4 pure lime—1.80 of magnesia—1.80 of clay (silex and alumine.)

Meagre lime from Coulommiers 78.00 pure lime—20.00 of magnesia—2.00 of clay (silex and alumine.)

Lime moderately hydraulic from Saint-Germain—89.00 of pure lime—1.00 of magnesia—10.00 of clay (silex and alumine.)

Lime very hydraulic from Senonches—70.00 of pure lime—1.00 of magnesia—29.00 of silex. To these analyses we will add:

Meagre lime of Brest—82.30 of lime—10.00 of oxide of iron—7.70 of clay.

We see from these analyses that silex, whether pure or mixed with alumine, renders lime hydraulic; and that magnesia, or the oxide of iron, renders it meagre and not hydraulic. Mr. Berthier found the same consequences when proceeding synthetically: he ascertained that silex in jelly, calcined with pure lime, gave an hydraulic product; that alumine, magnesia, oxide of iron, and oxide of manganese, calcined, one by one, with pure lime, gave a meagre lime only: that alumine or magnesia mixed with silex increased the hydraulic property, and, lastly, that the proportions the most favourable for the mixture were equal parts of silex on the one hand and alumine or magnesia on the other.

A consequence results from these considerations which it is important to mention: it is this, that the process of Mr. Vicat for preparing artificial hydraulic lime, does not answer equally well on taking any limestone or clay that may present itself: that it is, with difficulty, applicable to mea-

gre limes mixed with ochreous clays, and that this is the case at Brest, where, the matters being charged with oxide of iron, nothing passable was obtained, and we were obliged to resort to puzzolanas.

§ 32. *On the solidification of hydraulic lime.*

Hydraulic lime slaked in the ordinary manner solidifies a certain quantity of water as fat lime does; and forms, with an excess of water, a paste, more or less stiff. If left exposed to the air, it absorbs less carbonic acid than fat lime; and, like fat lime, it retains the water it had solidified.

According to Mr. Vicat there are in 100 parts of fat lime	= 100.00
Absorbed carbonic acid	76.00
Retained water	17.00
And in 100 parts of hydraulic lime which contains a fifth of its weight of clay:	
Absorbed carbonic acid	54.00
Retained water	15.00
But this last result may be put under the following form:	
Pure lime	100.00
Clay	25.00
Carbonic acid	67.50
Water	18.70

It differs therefore, in this respect, very little from fat lime, so that it is equally a *hydro-carbonate* of lime, the clay appearing not to enter into the combination.

On the other hand, when the paste remains immersed in water, the aid of the carbonic acid is no longer possible, and that of the silex becomes indispensible to solidification. It remains to seek the cause of this phenomenon.

1st. Pure lime is soluble in five or six hundred times its weight of water, and the product is called *lime water.*

2nd. Pure lime combined by calcination with gelatinous silex is only partially soluble in water, and leaves a residue, composed of sixty-five parts of silex and thirty-five parts of lime, which is known under the name of *neutral silicate of lime.*

3rd. Pure lime combined in the same manner with alumine, magnesia, oxide of iron, or oxide of manganese, although it has lost the property of swelling much, or slaking, is still soluble in water, and the residue contains nothing but pure alumine, or magnesia, or the oxide of iron or manganese.

4th. In order that a lime may be hydraulic, it will suffice that it possesses six or seven per cent. of silex, a quantity that can render only a very small dose of lime insoluble.

5th. Plastic cements, at the point of complete calcination, may be assimilated to ordinary lime—they are but slightly hydraulic, although they contain a considerable portion of silex.

We see then that the combination of silex with lime has, alone, the advantage of resisting the attacks of water: that if alumine and some other oxides raise the hydraulic energies, it arises probably from this, that the obstacle they interpose to the swelling of the lime tends to the concentration of the molecules, thereby helping their predisposition to submit to the influence of the silicate of lime: and that free lime, notwithstanding its solubility, ought always to predominate in the immersed paste.

The question being thus stated, it is necessary to explain two effects; the insolubility, and the hardness, acquired by mortars under water.

In the first place, it cannot be admitted that the silicate of lime solidifies separately, and that it envelopes the hydrate as a gangue; for the last would not be less soluble, and the hardness acquired would be proportionate to the quantity of silicate, which, in general, is not true. Every thing leads to the opinion rather, that the molecules of silicate are so many centres of attraction, with respect to the soluble molecules, and that, within the sphere of activity of each of these centres, there is an arrangement which may be assimilated to a true *crystallization*.

On this hypothesis, we conceive, the most proper proportion of silicate, is that which leaves around each molecule thereof, a layer of hydrate equal in thickness to the radius of the sphere of attraction: that below this term, that is to say, in measure as the silicate becomes more abundant, the layers of interposed hydrate are submitted to attractions which interfere with and disturb, instead of mutually aiding, each other, that above this term, that is to say when the silicate is in too small a quantity, the layers of hydrate may still solidify, not so soon, nor wholly by the direct action of the silicate, but by the influence of the particles nearest the silicate, which, in measure as they solidify, react in their turn upon others: as in saline solutions, a crystal already formed may be the proximate cause of crystallization.

It may in the same manner, be conceived that hydraulic mortars have need of moisture rather than dryness, because the water preserving to the molecules a certain mobility, permits their arranging themselves in juxtaposition by the proper facets. It must not however be concluded that soft mortars would be preferable to mortars in stiff paste: because the water augmenting too much the distance of the molecules, would throw them beyond the sphere of mutual attraction: hence one of the causes why hydraulic mortars are generally less hard on the surface than in their central parts, while it is the reverse with all mortars made of fat lime and hardened in the air.

§ 33. *On the influence of the dissolving action of water.*

This fact has relation to another cause on which it is important to insist.

When hydraulic mortar is immersed in the bottom of any vessel, two opposite molecular forces are set in action: on the one hand, the action of the silicate of lime on the hydrate, and on the other, the solvent force of the water with respect to this same hydrate. The water being supposed tranquil, the lower portions of it dissolve the lime: but as this water becomes more dense it remains at the bottom, without power of removal; and the lime thus dissolved cannot be transferred to the upper portions of fluid except by the play of affinities—by a transmission analogous to that of carbonic acid in the interior of mortars made of fat lime. However that may be, the portion of water in immediate contact with the mortar losing its solvent power in proportion as it approaches the term of saturation, an equilibrium will soon be established between the two opposite molecular forces, and then all solution will cease. But if the superficial layer of mortar has lost a small portion only of its hydrate, this equilibrium, will, as regards the progress of solidification of the mortar, be only instanta-

neous: this layer might in fact continue to take cohesion from the influence of the under layers of mortar not attacked by the water.

If, on the other hand, the liquid be agitated, in order to render the saturation uniform throughout the mass of fluid—or rather, if the mortar be immersed in running water, it may happen that the exterior layers of mortar will, little by little, lose all, or the greater part, of their hydrate; but this effect not being brought about instantly, the interior layers would be protected for a time sufficient for them to harden beyond its solvent power before becoming, in their turn, exposed to the action of the water. We can conceive, therefore, that mortars may wash away for a certain depth: and that thickness may be an indispensable condition to the success of the solidifying process.

§ 34. *Influence of Quartzose Sands.*

As the practice is to use hydraulic limes, not pure, but mixed with sands, it is important to study the influence of these sands on the induration of mortars. We shall speak here only of quartzose sands, which are the most common.

It is demonstrated by experiments that caustic lime, cold or hot, is without any action on quartz in discernible particles: if, then, it adds to the quality of hydraulic mortars, it can only be because, 1st. it augments the density of the mass, and thus prevents its being brought to the state of soft mortar by being too easily permeable to water: or, 2nd. because its adherence to the lime, however feeble it may be supposed to be in the first instance, is an accelerating cause of crystallization. That this should be so, it is not necessary to suppose that the sand exercises a chemical action on the lime: because we know, for example, that in the preparation of rock-candy, and of verdigris or acetate of copper, &c. it is only necessary to stretch threads, or place sticks of wood, in the solutions, to determine the crystals to group around them like clusters of grapes, while none show themselves any where else. Sands in this, do no more than aid the tendency of hydraulic limes to take cohesion; and their influence is null when this tendency does not exist, as for example in fat lime. If the experiments with this last lime be attentively examined, it will be seen that they harden better alone than when mixed with sand: that the particles of hydro-carbonate have greater cohesion amongst themselves than adhesion to sand; whence it naturally follows that sands which divide the mass most thoroughly, that is to say, the finest sands, are the worst, because in an equal section the extent of surfaces in contact is the greatest. The contrary takes place in hydraulic limes, according to Mr. Vicat. If some experiments of General Treussart do not accord with these ideas, it seems to be owing to the too great quantity of sand used in his mortars.

§ 35. *On the solidification of deteriorated hydraulic limes.*

We have seen, at the commencement of this article, that hydraulic limes slaked spontaneously in the air, and not used for some time, lost their energy, more and more. We will add an analogous fact that we have had occasion to observe; it is that the hydraulic lime of Doué preserved for two years in flagons, well stoppered, so as to prevent any change of air, or the absorption of humidity, remained in fragments it is true; but these fragments had lost the power of slaking, and also of setting under water, after

having been tempered like plaster. What has occurred in this case? This we have to explain.

It is well known that the limestone affording hydraulic lime, when treated, before calcination, with muriatic acid, leaves generally an insoluble residue composed of silex and alumine; but that immediately after calcination, the same stone, now become quick lime, is completely soluble, which shows the existence of a chemical combination: this being premised—we have taken hydraulic lime which had been slaked in air for two months; treated it with muriatic acid in excess, and it gave a considerable gelatinous residue: we have treated hydraulic lime preserved for two years in the same way, and the gelatinous residue was so abundant that we were forced to believe there could be no silex dissolved with the lime. But however that might be, is it not evident that the silicate of lime is decomposed, at least in part? that, therefore, in the case of the deterioration of hydraulic limes, the silex having taken cohesion, is only to be considered as being mixed intimately with the lime, and consequently can do no more than perform the office of puzzolana mixed in small doses with fat lime. Hence the great inferiority of the results, and the necessity of remedying them by the method of General Treussart.

§ 36. *On the solidification of Puzzolana Mortars.*

Let us pass now to the case of puzzolana mortars. According to what has been said before, an indispensable condition to the solidification of lime under water, is, that a small portion of this same lime be first rendered insoluble—each of the insoluble particles becoming the centre of attraction with respect to the surrounding layers of hydrate. Is this condition fulfilled on mixing fat lime with puzzolana? This is put beyond doubt by Mr. Vicat showing that puzzolanas have the property of precipitating lime from its solution in water, and that their energy is proportionate to the quantity of lime water they can thus precipitate. Whatever may be the cause of this property, whether it does, or does not, belong to a chemical combination between the lime and puzzolana—a combination difficult to conceive on account of the state of cohesion of the silex—a cohesion assuredly much greater than in deteriorated hydraulic lime, it is not less true that this fact suffices to establish a satisfactory analogy between the solidification of puzzolana mortars, and those made of hydraulic lime. It may be inferred from thence that the mixture of puzzolana with slightly hydraulic lime will give good results, because in such limes the proportion of hydrate would not be superabundant; with limes very hydraulic, it may be inferred, on the contrary, that this mixture would become injurious, because the proportion of lime would be too small, and there would result a kind of plastic cement, at the term of complete calcination.

The puzzolanas are mixed like sands, in the proportion of one and a half to two and a half in volume, to one of lime in paste. This proportion supposes, no doubt, much more silex, than is required to constitute hydraulic limes; but it must be remarked that in these limes, all the particles act in the most favourable circumstances possible, while in the above mixtures, they are collected in grains of some size, acting only by their surfaces, and their action being weakened by the cohesion that they already possess in a high degree.

§ 37. *On the solidification of Plastic Cements.*

Let us, in the last place, see to what degree the principles previously admitted will serve to explain the solidification of plastic cements, in the most general case; that is to say, as was explained at the end of article XVIII, section 25.

1st. In fat limes imperfectly calcined or super-calcined, the particles carbonated or super-calcined, requiring to be worked to make a paste with water, and being convertible into hydrate only with difficulty, it may be conceived to be not impossible that they play the same part as lime rendered insoluble by silex or by puzzolana, and that thus the commencement of hydraulic quality is obtained.

2d. In hydraulic limes imperfectly calcined, the particles of carbonate act in the same manner, but with this advantage that their influence on the solidification is increased by that of the silicate of lime which is present.

In the same lime stones carried to the second maximum of energy, the particles of carbonate are replaced by the equally insoluble super-calcined particles.

3d. In the septaria furnishing the ordinary plastic cement, the clay is too abundant to leave, at the term of complete calcination, the proportion of hydrate of lime necessary to a good solidification: the imperfect calcination, then, has for object to render the silex only partially soluble in acids so that it may the more resemble the mode of action of puzzolanas.

Lastly, at the term of super-calcination, the clay of these same lime stones passes to a state of less energetic puzzolana than at the term of complete calcination, and thereby leaves a greater proportion of lime susceptible of conversion into hydrate.

The developments into which we have entered relative to the solidification of mortars in general, are far, no doubt, from exhausting the subject; and require to be sustained by numerous experiments. We are fully aware of this; but our object not being to present a treatise on mortars, we have restricted ourselves to so much as is useful in understanding the operations of lime burning, which we have described.

[TO BE CONTINUED.]

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN JULY, 1837.

With Remarks and Exemplifications by the Editor.

(CONTINUED FROM P. 274.)

196. For a machine for *Reducing Thread Waste into Wool;* William Gray, Hebron, Tolland county, Connecticut, July 29.

Although this machine is for the same purpose as that noticed at No. 170 for the same month, it is not the same in construction. By referring to No. 170 it will be seen that the separating the waste thread into its original fibrous state is to be accomplished by it, principally, by beating against slats, or knives. In the present machine the reducing is principally effected by the operation of rollers set with points, between which it is passed. The claim made is to the reducing by "passing it successively between feeding rollers on to reducing rollers, whence it is delivered on to endless aprons,

and pressed by pressing rollers, preparatory to its being again acted upon by reducing rollers." The pressing rollers upon the endless apron press the partially reduced thread into a bat, preparatory to its being again acted upon by reducing rollers.

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197. For improvements in *Cooking Stoves;* Edwin Reed, West Bridgewater, Plymouth county, Massachusetts, July 29.

The claim made in this stove is to the particular arrangement of the dampers, so as to govern and direct the fire; to certain peculiarities in the construction and direction of the flues, and to the thereby heating those parts effectually which most require it. There is more novelty in this than in the greater number of stoves offered for patents, and we doubt not that it will operate well, and from good materials prepare a good meal.

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198. For an improvement in the manner of constructing *Ovens for Stoves;* David W. Barker, Clyde, Wayne county, New York, July 29.

This oven stands above the stove, like a closet, or book case. It has shelves upon which to place the viands, and doors which open on the front and back. The ends and top are double, forming flues from the stove below it to the pipe which rises from the centre of the top, there being valves to govern the draught. The claim to the "oven is the particular manner in which it is connected to and combined with, the fire place, or stove; that is to say, standing above and behind the fire chamber, with a flue leading therefrom under it, and up at each end only of the oven, which oven has doors at back and front, in the way described."

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199. For improvements in the framing of *Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

This patent is taken for a particular manner of framing the carriage part of the locomotive, and of covering the sides of the framing with continuous sheets of iron, and is particularly adapted to the kind of engine built by Mr. Winans.

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200. For an improved *Coal Cooking Stove;* William Kenney, Louisville, Jefferson county, Kentucky, July 29.

We can only again repeat as regards this stove, what we have said respecting many others, that the claims are founded on the manner of directing the flues, and of governing the passage through them by means of valves differently situated. It will readily be believed that the differences are in many cases very trifling, consisting sometimes of little more than a change of shape, which although it may not be calculated to make any material change in the action of the apparatus, will be considered by the *inventor*, as a thing of primary importance, the denial of a patent for which would be an outrage upon genius, deprive him of fortune, and the public of the benefits of a magnificent discovery, unless he should give it as a free will offering.

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201. For an improvement in the *Apparatus for blowing the fire in Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

In the engines used on the Baltimore and Ohio railroad, anthracite has been generally used as a fuel, and some of these engines have been put upon

other roads. Where this fuel is employed it has been found necessary to quicken the combustion by a blowing apparatus, and this patent is taken for an improvement upon such an apparatus formerly used.

The improvements claimed are "first, the varying, increasing, and regulating, the blast created by the fan wheel, by contracting or enlarging the passage, or aperture, through which the steam issues on to the fan wheel, substantially in the manner and for the purpose described. Secondly, the placing of the steam and fan wheels upon an upright shaft, and the arrangement of the different parts in conformity therewith, which enables me to combine the steam and fan wheels in a convenient and compact form for the use of locomotive engines."

The fan wheel is driven by the action of the waste steam, as in the engines of the late Phineas Davis, whose patent is now the property of Mr. Winans.

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202. For improvements in *Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

This patent is taken for the manner in which the patentee has combined a vertical boiler with cylinders placed horizontally; and for the manner in which he has combined these with a spur and pinion wheel shaft, which operates upon the road wheels. There is much skill displayed in the mode of arrangement and combination, which are made clear by the drawings appended to the specification, and which cannot be understood without them.

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203. For an improved *Cooking Stove;* James Richardson, Poultney, Rutland county, Vermont, July 29.

This is a square stove, with a fire place resembling that in Stanley's rotary. The top plate also has projecting rims connected together by semicircular flues, as in the top of Stanley's stove. Behind the fire there is an oven, under which there is a flue, for the passage of heated air. The patentee states that "The novelties in this stove are, *First*, That the fire and heated air may be driven downwards through the openings in the grate, under and past the oven, while the grate and fuel are placed at different heights above the top part of the flue, under the oven, and at a higher elevation than the oven bottom. *Second*, In the oven there is a horizontal plate, covering the whole size of the oven at the bottom, and resting about one inch above it. This plate has several oblong or tapering holes or apertures therein, which are from one to nine inches in length, and one inch wide at the widest part. These holes or apertures commence near the back and cooler parts of the oven plate, and run towards the front part of the oven, diminishing in length as they approach the centre of the plate. This plate is called the upper, or movable, oven plate. The object of the last described plate, with apertures therein, is to assist in equalizing the heat in the oven, by discharging the heat which is created in the under oven bottom through these holes, to the back, or cooler part of the oven." The claims made are in accordance with the foregoing statements.

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204. For improvements in *Locomotive Steam Engines*, by which they are adapted to undulating and curved roads; Ross Winans, Baltimore, July 29.

The claim under this patent will afford a good general idea of the princi-

ple of regulation, and of the mode of procedure by which this principle is to be carried into effect.

"What I claim as new in the foregoing specification, and for which I ask an exclusive privilege is:

"*First.* The connexion of the power to four or more wheels, and the use of much larger cylinders than usual, in proportion to the weight of the engine, expressly with a view to, and in combination with, the cutting off the steam at different portions of the stroke of the piston, by means of which arrangement and combination, the object before stated, of adapting locomotive engines more perfectly to undulating and curved roads, to heavy and light loads, and to slow and fast speed, than heretofore has been effected.

"*Second.* The use of two, or more, arms operating on the slide valves, admitting the steam immediately to the cylinders, for the purpose of cutting off the steam at different portions of the stroke of the piston, as before described, thereby economising the steam, and consequently the fuel, and better adapting the engine to the duty it may have to perform, with different loads, and on varying grades of the road. The use of several cams, or of one cam so constructed as to perform the office of several, as herein-before described, I believe to be new in itself, separate and apart from the combination herein claimed, and applicable to every species of locomotive engine with advantage, and, as such, I claim a patent for it. The cutting off the steam at a portion of the stroke by a cam operating on the slide valve, has been long known and used on locomotives and engines; but the change in the time of cutting off the steam, as described herein, and thus being able to work the engine at full, half, or other, stroke, at pleasure, while the engine is in motion, has not before been done by a cam, or cams, operating on the same valve. An arrangement has been used for cutting off the steam at some one portion of the stroke, and changing from that to full stroke, at pleasure, while the engine was in motion, similar to that practiced in most of the steamboats of the present day, by having a throttle, or separate valve, moved by a cam, or eccentric, or crank, and so arranged as to cut off the steam at a portion of the stroke when desired. This, however, does not interfere with either of my claims, inasmuch as my *second* claim is for a mode of effecting the cut off by means of the same valve that admits the steam to the cylinder, and without a separate valve; neither does it interfere with my *first* claim, inasmuch as the cutting off the steam, and working at full stroke, at pleasure, has not been done in combination with the arrangement of connected wheels and large cylinders, as herein described—and which arrangement, in combination with the cutting off the steam, as herein described, is of the utmost importance in effecting the object of my invention, to wit, the adaptation of the locomotive engine to undulating and curved roads more perfectly than heretofore, or to roads where considerable variation in the power of the engine is required."

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205. For apparatus for *Heating Water for Steam Boilers;* Ross Winans, Baltimore, July 29. (See specification.)

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296. For an improved *Revolving and Sifting Grate;* Enos B. M. Hughes, City of New Haven, Connecticut, July 29.

This is a grate which may be set in an open fire place as a substitute for the ordinary grate for burning anthracite. It has flat ends, which may be

made oval, and between these ends there are bars which continue all round, those constituting the upper part being made to open for supplying fuel. The ends are each made of two cast iron plates, the innermost of which has a rim to contain a lining of fire brick; and from the outermost of each extends a gudgeon upon which the grate is supported, and upon which it is made to revolve, for the purpose of sifting out the ashes.

Claim. "What I claim as my invention, is a revolving grate, with non-conducting ends, and all sides formed with open bars, which grate confines the burning coal, and sifts and cleanses it from ashes, and other small incombustible particles. And I claim only what is necessary to the construction of a grate which combines non-conducting ends, all its sides formed with open bars, and a revolving motion, as described."

Grates suspended upon gudgeons, and having bars all round, are not new, and could not be claimed alone, and of this the patentee seems to be aware; the nonconducting ends, in a grate so suspended, is the only novelty, and this must be understood as the basis of the combination claimed.

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207. For an improved mode of fixing *Weather Strips to the Bottoms of Doors*; Isaac D. Brower, New York, July 29.

The weather strip used is a strip of metal let into a groove along the lower edge of the door, and closing, when down, against a rebate along the sill. The strip is attached, in the middle, to a sliding bolt enclosed within the framing of the door, and it is raised by the action of the knob which moves the spring-bolt of the lock, by attachments contained within the frame work. The closing of the strip is effected by a sliding rod which projects out from the hinged edge of the door, the pressure of which against the rebate in the door frame insures the descent of the bolt and the strip to which it is attached. The claim is to the arranging and combining the respective parts, so as to operate upon the weather strip, in the manner described.

The arrangement is made with much ingenuity, and we perceive but one difficulty in the way of its action; we feel assured that the appendages to the sliding bolt of the lock, by which the strip is to be raised, will cause the handle to turn with some difficulty. We apprehend, also, that the application will be too costly for general adoption.

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208. For *Paddles to be used as Ice Breakers and Propellers*; Washington Van Dusen, Kensington, Philadelphia county, Pennsylvania, July 29.

The paddles used in this boat are fixed upon jointed frames, which are actuated by crank motion, in such a way as to cause them to dip into, and leave the water nearly at right angles to its surface. The paddles are to rise entirely out of the water, and as they are to be used as ice breakers, they are to be made of iron and steel. The crank is of considerable length, say five feet, and the paddles, or breakers, are brought into contact with the ice when the crank is at its point of rapid descent.

The patentee notices the previous use of paddles operated by crank motion, and points out the difference in construction, and action, of those used by him. The claim is to "the method of operating the paddles, or ice breakers, by means of a crank at one end of a crank frame, having at the other end a vibrating frame, as set forth. Also, the employment of such a paddle frame lengthened out, and sliding back and forth, horizontally, be-

tween guides, whether used for breaking ice and propelling at the same time, or for propelling simply."

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209. For *Bandages, Pads, &c., for Hernia, &c.;* Robert Thompson, M. D., Columbus, Franklin county, Ohio, July 29.

The patentee claims to have made improvements "in the mode of constructing bandages, pads, and other articles connected therewith, for the purpose of giving support to debilitated portions of the human system, and of effecting a cure, or producing relief, in cases of hernia, prolapsus, and other similar affections.

The instruments used are necessarily various in their construction, as they are to be applied to several different objects. The claims made are to "the employment of perinæal straps, in the manner set forth. The manner of making and adapting the abdominal bandage to the form, and to the support of the abdomen, by the employment of an elastic band of webbing along its lower edge, serving as a constrictor to it. The formation of a pad for hernia, by taking an impression of the part to which it is to be applied, for the purpose of procuring a pad possessing the exact form thus obtained, by casting, carving, or otherwise; and the mode of applying such a pad by confining it in its place under a bandage unattached thereto, or to any of the usual appendages of such pads. Also the employment of a spiral pad combined with the elastic strap proceeding from what I have denominated the abdominal portions, or bandage, and uncombined with a steel or other spring with which such pads have heretofore been connected, for the purpose of effecting a counter pressure, which makes no part of the object had in view by me in its employment. And, lastly, the use of a forked strap, having its hinder, or forked ends, attached to the back portion of the pelvic strap, giving support to the hips, as they proceed towards the pad from which they bifurcate."

But a very imperfect idea can be formed of the foregoing devices, without the drawings which accompany the specification. Some of the particulars named, are, however, sufficiently tangible, and as we believe, new. In the use of bandages we think that but little room is left for novelty of invention, and we believe that they rarely, therefore, afford sufficient ground for a claim under a patent; but when previous use of such as are identical with those claimed cannot be shown, the office grants a patent, and the risk of sustaining it is, of course, with the claimant.

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210. For an improved *Rotary Steam Engine;* David Grannis and David E. Brand, Collins, Erie county, New York, July 29.

The claim under this patent is to "the manner of working the draw buckets by means of pins working in grooves, or upon guides made upon the inside of the heads of the cylinder." The machine belongs to that class in which there are two valves, "draw buckets," against which the steam is to act alternately as one cylinder revolves within another. The only novelty is in the mode of withdrawing the valves, by means of eccentric grooves; a thing which has been effected in various ways, some, of course, more simple, and so far better, than others, but the best of them not approaching a single step towards the removal of those deep seated objections which lie against all rotary steam engines, and in an especial manner against those in which there must be close fitting valves, to open and close in a revolving apparatus. We wish that we could bestow a word of praise

in the present case, but as we have no hope, we cannot attempt to inspire any.

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211. For a machine for *Dressing Sawed Shingles, &c.;* Geo. L. Day, Union, Browne county, New York, July 29.

The shingles are to be dressed by means of cutters upon a cutter wheel, much in the manner of those used in some planing machines. The principal novelty in this machine is the manner of arranging and governing the action of the feeding rollers, by which the shingles are guided, and the claim is to this peculiar arrangement.

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212. For a *Machine for Cutting Screws;* Joseph Blackhall, city of Albany, New York, July 29.

There is very little novelty in the *invention* which forms the subject of this patent. Three poppet heads, in a line with each other, are placed upon a suitable bed; through collars in two of these passes a shaft or mandril which has forceps at one end for gripping the piece which is to be cut by passing it between dies in the third head. The mandril is to be turned by a winch, or otherwise. Some of the things claimed are of doubtful originality, and we do not see any which render this machine superior to others that have been used for the same purpose.

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213. For improvements in the *Machinery for Breaking and Dressing Hemp and Flax;* Chapman Warner, A. T. Mixsell, and E. I. Horn, Belvidere, Warren county, New Jersey, July 31.

Claim. "What we claim as our invention is the manner of constructing the breaking apparatus as herein described, consisting of a vibrating frame of beaters, operating between two stationary frames adapted thereto, and having the hemp or flax fed in on each side of the vibrating frame, by the aid of clamps, carried forward by an endless chain or band. We claim also the manner of forming the dressing apparatus, with its knives affixed upon a hollow drum or cylinder, and having a fan wheel within it, operating in the manner and for the purpose set forth. We likewise claim the vibrating frame of the hatcheling apparatus, in combination with the cams, or guides, constructed substantially as herein fully made known."

It will be seen by the foregoing claims, that the construction of this machine cannot be readily given without the drawings. In its general operation it resembles some others, but there appear to be various provisions in most of its parts entitling it to the character of novelty. In an operation where so many machines have failed altogether, or but partially succeeded, we will not pretend to anticipate the fate of this; but in point of arrangement it has merit. The dressing apparatus spoken of "consists of a hollow drum, or cylinder, revolving horizontally, having dressing knives projecting from its periphery, and a fan or wind wheel within it, revolving in a direction the reverse of that of the drums, the wind from which passes out through mouths or openings in the periphery or drum, in the spaces between the dressing knives, the current of air passing out from the wind wheel opening the fibres, tending to keep them up against the dressing knives, and blowing out the shivers so as to separate them completely from the dressed hemp or flax."

214. For an improvement in the mode of *Printing and Drawing Checks to prevent Counterfeits;* John Dainty, Philadelphia, July 31.

This is one of those devices the ingenuity of which will not cause its adoption. One thing claimed is what the patentee calls a "safety bar," in which the amount is to be written in figures. A plan of combining figures and letters is also explained and claimed; also a particular mode of making entry in a register, or firm book.

If a person cannot find half a dozen merchants who will adopt a plan like the foregoing, if allowed to do so free of charge, the inference is a fair one that they will not pay for it for the sake of the parchment, the great seal, and the patent right.

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215. For a machine for *Turning Mouldings and Beads;* Eli Coddington, Thompson, Sullivan county, New York, July 31.

This machine appears to be principally intended for turning such articles as broom and brush handles, which are simple in their form. The stuff to be turned is fixed by one end in a chuck in a collar and mandril lathe, and a sliding head, furnished with suitable guide pieces, and cutters, is forced up against it; in this head there are cutters so formed as to cut beads, hollows, or other simple members of mouldings, which cutters may be brought down upon the stuff in the proper places. It is to this part that a claim is made.

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216. For an improvement in the *machine for bending the Tire of Wheels, and other articles;* Thomas C. Barton, New York, July 31.

The bending is to be effected by means of three rollers not differing materially from those frequently used for the purpose; but there is an adjustment of one of the rollers by the combined action of a frame, lever, and screw, which arrangement forms the subject matter of the claim.

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217. For a *machine for drilling the tire of wheels;* Thomas C. Barton, New York, July 31.

The drill is fixed in a mandril running in collars; the devices which form the subject of the patent, are for fixing and using the drill more conveniently than heretofore, when applied to the drilling of tire, and the claim is confined to this particular arrangement.

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218. For a *machine for Husking Corn;* Jonathan Cutler, Pickney, Windham county, Vermont, July 31.

Two iron rollers which may be thirty inches long, and an inch and a half in diameter, are fluted from end to end, and placed in a frame, where they are geared together, and made to revolve horizontally on suitable bearings, and nearly in contact with each other. The corn to be husked is fed down a wooden trough so as to fall between the rollers, the flutes of which seize the husk, and draw it off. The ears of corn are thus successively supplied, and pass off at the far end of the roller. The claim is to a machine constructed substantially in the manner of that described.

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219. For improvements on *Drawer, Commode, and Cupboard door knobs;* David Hoffman, city of Baltimore, July 31.

The specification is as follows. "The nature of my improvement con-

sists in inserting, or otherwise fastening, topically stained, painted, coloured, gilt, or silvered glass plates of various patterns and sizes, into stocks of wood, with either metal or wooden spindles; and for the purpose of variagating and increasing the brilliancy of the colours I place either coloured foil, coloured paper, coloured glass, coloured metals, or looking glass, underneath said plates according to the patterns required." The claim is to the knobs so made, as a whole; and if the whole of those made resemble the specimens deposited in the Patent Office, we apprehend that the patentee may not only claim, but actually keep the whole.

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220. For a new mode of constructing *Paddle Wheels for propelling Steam Boats;* William A. Douglass, Albany, New York, July 31.

By a particular arrangement of levers, joints, and slides, the buckets of the paddle wheel are to be made to enter and leave the water vertically, or at such angle as may be preferred. The same thing has been accomplished by other modes of construction, some of them less complex than that here proposed; so far, however, as the results of experience have been known, all devices of this kind have proved worse than useless, not in the slightest degree accelerating the speed of a boat, whilst they consume a part of the power of the engine, and are much more costly at first, as well as more liable to derangement, than wheels with the ordinary fixed paddle. The patentee claims the particular mode of construction invented by him.

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221. For a *Plough;* John Deats, Roxburg, Warren county, New Jersey, July 31.

The claims made in this plough, are to "the manner of forming the pattern of the mould board, so as to cast it to deliver from a single flask, with a tenon, or pin, cast near its front edge, in the manner, and for the purpose, described." There are also certain claims to the manner of constructing particular parts, as explained in the specification.

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222. For a new mode of *attaching Knives or Dirks to Pistols;* Robert W. Andrews, Stafford, Tolland county, Connecticut, July 31.

"The nature of my invention consists in so attaching a knife or dirk, to a pistol, or other small fire arm, as that the breech, with its lock, guard, and other fixtures, being separable from the barrel, shall serve as a convenient handle, or hilt to the knife, or dirk, making use of the blade as an essential means of connecting the breech, lock &c. with the barrel, to form the piece entire."

To the under side of the barrel, is attached, a sheath, or scabbard, which slides over the knife, or dirk, affixed to the stock, making, when in place, an entire pistol. The claim is to "attaching the scabbard to the barrel, and making it an essential part in holding the piece strongly and firmly together."

223. For improvements in the *machine for cleaning and dressing Feathers;* Samuel Sweet, jr.

There are two drums, or cylinders, one placed above the other, within a case, and an endless band or apron passes round these cylinders. The upper cylinder revolves on gudgeons, the lower lies in the apron, which it keeps stretched by its weight. The apron is set round with projecting points, the case being large enough to admit of their passing round with the apron. The feathers are to be contained between the apron and the case, and are agitated and carried round by the points; there being provision made to supply the requisite degree of heat. The claim is to "the revolving belt, with pins, or hands, revolving round two drums inside of a case adapted thereto, in the manner, and for the purpose, above specified."

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224. For a *Locomotive Power Machine for removing Houses, &c.;* Stephen Compton, Almira, Chemung county, New York, July 31.

This machine consists of a combination of wheels and pinions upon suitable shafts, operating upon a windlass; from this windlass a rope, or chain, is to be extended to a house, stump, or other body to be removed. The machine is mounted upon wheels, and is so constructed that "the end of the frame towards the resisting body may be brought into contact with the ground, this end being armed with iron, and so formed that it will enter, and form a bearing against the earth, with a power of resistance proportioned to that applied. The claim is to "the mounting of such a machine upon a carriage, constructed in the way described, so that it may readily be removed from place to place, and that it shall anchor itself, or take firm hold in the ground, by the action of the power applied, substantially in the manner shown."

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225. For *smelting Iron Ore by a composition of Anthracite and Clay as a fuel;* Joseph Lyon, Pottsville, Schuylkill county, Pennsylvania, July 31. (See Specification.)

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226. For a *Stove for Heating and Cooking;* Rufus S. Payne, West Springfield, Massachusetts, July 31.

This stove differs so little from several others, that it is not worth while to give the claim, which is only to certain special matters of arrangement.

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227. For *preparing Oleaginous Seeds for pressing;* James Crisswell Pittsburg, Pennsylvania, July 31. (See Specification.)

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228. For a *Stove for Heating apartments;* Philip Willcox, Springfield, Massachusetts, July 30.

The remarks made on stove No. 226, will apply to that now under consideration; the claim would not make known the peculiarities of construction upon which they are now founded.

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229. For a process for *removing Wool and Hair from Skins;* Benjamin F. Emery, Bath, Lincoln county, Maine, July 31. (See Specification.)

230. For an improvement in the construction of *Water Wheels;* Clayton Parker, and Robert W. Engle, Wayne, Warren county, Ohio, July 31.

This wheel, it is said, is to be "propelled mainly upon the undershot principle, and to revolve with its shaft vertical. "Its construction is peculiar, and would require drawings to make it known. The water is to pass down through openings near the periphery, which descend spirally, but differ in their arrangement and combination from others which have a resemblance to it. There is also a peculiarity in the mode of letting on the water, and of regulating its quantity. The claims are to "the giving to that part of the water wheel which is within the buckets, the form of a hollow drum, provided with openings, in its upper and lower heads, made in the manner, and for the purposes set forth. The raising or closing the gates of all the chutes simultaneously, substantially in the manner described. The plan of continuing one half of the buckets, down for about one half of the depth of the wheel, and the forming of an elbow in the other half of our buckets, half way down the wheel; thereby causing it to receive its main propelling power on the undershot principle, and to operate well in back water."

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231. For an improvement in the mode of constructing *Rail Road Frogs;* George S. Griggs, Roxbury, Massachusetts, July 31.

"By a railroad frog is meant the rails at places, where two rails cross each other. The frog has heretofore been cast or constructed in one entire piece, forming the two crossing rails for the distance of from two or three, to seven or eight feet." It is stated that from the exposure to severe shocks, and wear, at these crossing places, they are liable to great and frequent want of repair; and the improvement described, consists in providing plates of steel which are to be bolted on to the cast frogs, the bolts having flush heads. These plates can be removed when required, and new ones substituted. The claim is to "the frog plates above described, and applied as aforesaid, of whatever materials formed, and however attached to, and connected with, the main body of the frog rails."

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232. For an improvement in the machine for *Crimping Leather for Boots;* Moses S. Woodward, Marshalton, Chester county, Pennsylvania, July 31,

The improvement described consists, principally, in the means adopted for holding the leather in place whilst it is dried upon the former. The machine, in its general construction, is like several others used for the same purpose.

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233. For an improvement in the mode of constructing the *Wheels of Locomotive Engines for ascending Inclined Planes;* Elisha Town, Montpelier, Washington county, Vermont, July 31. (See Specification.)

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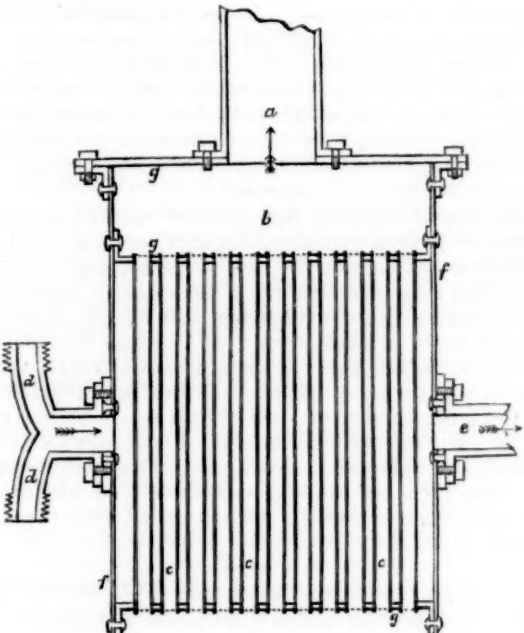
234. For a *Cooking Stove;* John Collins, Grafton, Worcester county, Massachusetts, July 31.

This stove has too much complexity in its individual arrangements to

justify the attempt to describe them verbally. The claim is to "the manner in which the heat is communicated to, and diffused through the oven of the stove or baker, in the manner described."

Specifications of American Patents.

Specification of a patent for an improvement in the mode of Heating the Water, which is forced into the boilers of Steam Engines by means of the Force Pump; granted to Ross Winans, *Civil Engineer, Baltimore, Maryland, July* 31, 1837.



To all whom it may concern, be it known that I, Ross Winans, Civil Engineer, of the city of Baltimore, in the State of Maryland, have invented an improvement in the mode of heating the water which is forced into the boilers of steam engines, by means of the force pump; and I do hereby declare that the following is a full and exact description thereof.

The apparatus which I employ is intended to expose the water to the heating influence of the waste steam from locomotive or other steam engines, as the said water is on its passage between the force pump and the boiler. This apparatus may be differently formed, but, for the purpose of illustration, I will describe it in the shape in which I have essayed it, and which I have found to answer the intention perfectly well.

I make a cylinder of metal, *f*, *f*, which may be twenty-four inches long, and fifteen inches in diameter, for an ordinary locomotive engine; this cylinder has at each end two metallic heads, *g*, *g*, which may be four inches, more or less, apart; the interior heads are perforated with numerous holes into which are inserted small tubes *c*, *c*, say of three eighths of an inch in diameter, which tubes are firmly attached, or fastened into the openings in the heads, thus establishing a number of passages through from one of the spaces *b*, *b*, between the heads at one end of the cylinder, to the space at the opposite end. The waste steam pipe, *a*, from the engine enters the head at one end of the cylinder, and a similar pipe, *a*, passes out from the opposite end; and in its passage from one to the other the steam must necessarily pass through the small tubes above named, which are contained in what may be denominated an enlargement of the waste steam pipe. In the side of the cylinder, I make two perforations, *d*, *d*, *e*, opposite to each other, into which openings the supply pipe, between the pump and the boiler is firmly inserted, thereby causing the cold water, as it passes from one segment of this supply pipe to the other, to become heated by its contact with the tubes through which the waste steam passes. The upper part of the supply pipe, between the system of heating tubes and the boiler, is furnished with a puppet, or other, valve, opening towards the boiler.

Although I have described the steam as passing through the system of small tubes, and the water as surrounding them, it will be manifest, to any one having the slightest acquaintance with the subject, that this order may be reversed, and the same effect upon the water be still produced; and also that, instead of the tubes, a system of partitions, to be alternately occupied by steam and by water, will be substantially the same with the arrangement before described.

In those locomotives, or other engines, in which the waste steam is employed to drive a blowing apparatus, as is the case with those used on the Baltimore and Ohio rail-road, and some others, the waste steam is allowed to perform this office before it reaches the heating apparatus; the means of doing which will not require any description, as it will be perfectly manifest to every competent engineer.

What I claim as my invention, and wish to secure by Letters Patent, is the heating of the water in its passage from the supply pump to the boiler, by means of an apparatus substantially the same with that herein described.

ROSS WINANS.

Specification of a patent for a new mode of Smelting Iron Ores by a mixture of anthracite and clay as a fuel; granted to JOSEPH LYON, *Pottsville, Pennsylvania, July* 31, 1837.

To all whom it may concern, be it known, that I, Joseph Lyon, of Potts-

ville, in the county of Schuylkill, and State of Pennsylvania, Collier, have invented, or discovered, an improved mode of smelting iron ores by the employment of a mixture, or composition, of anthracite and clay, as a fuel, which I call "*Clay-Coals,*" and that the following is a full and exact description of the same.

My improvement consists in reducing anthracite to a coarse powder, or screening, and mixing, or mingling, it, either by hand or machinery, with such portions of clay and water as may be requisite to bring the mass, or aggregate, to a consistence that may be readily made into balls, or be taken up by hand, or machinery, in portions of any shape, or size; when these *clay-coals* are dried, they can be used as fuel in the manner that coke, or charcoal, is commonly used in the reduction of iron ores. I intend to mingle portions of the limestone, or other fluxes, in the composition of the mixture, and also some of the finer portions of the ore, when either, or both, of these additions may be considered useful.

I do not claim the discovery, or invention, of combustible balls composed of coal and clay, for these have long been known and used for divers purposes; but what I do claim as my invention, or discovery, and desire to secure by Letters Patent, is the preparation of anthracite, or the composition of *clay-coals* as herein set forth, to be used as a substitute for coke, charcoal, or other fuel, in its application to the purposes of smelting iron ores.

JOSEPH LYON.

Specification of a patent for a new method of Heating Flax-seed, and other oleaginous seeds preparatory to expressing the oil; granted to JAMES CRISWELL, *Pittsburgh, Pennsylvania, July* 31, 1837.

To all whom it may concern; be it known, that I, James Criswell, of the City of Pittsburgh, and State of Pennsylvania, have invented a new and improved method of heating flax-seed, or other oleaginous seeds, preparatory to expressing the oil therefrom; and I do hereby declare that the following is a full and exact description.

The nature of my invention consists in conveying steam, by means of a tube, into a steam chest, flat on the top, with a rim round it; within which rim the seed is placed in such a manner as to expose it to the heat from the steam within the chest; the chest may be of any given size, dimensions, or construction, to suit the convenience of the manufacturer.

What I claim, therefore, as new, is the application of steam to the heating of flax-seed, or other oleaginous seeds, preparatory to the expressing the oil therefrom, by means of any apparatus so constructed as to expose the seed to the heating influence of the steam, no claim being made by me to the apparatus used.

JAMES CRISWELL.

Specification of a patent for a method of Softening Hides and Skins, and of removing wool, hair, and bristles from them; granted to BENJAMIN F. EMERY, *Bath, Lincoln county, Maine, July* 31*st*, 1837.

To all whom it may concern, be it known, that I, Benjamin F. Emery, of Bath, in the county of Lincoln, and State of Maine, have invented, or discovered, a new and useful improvement in the method of softening hides and

skins, and of removing wool, hair, or bristles, from them. This improvement is effected by the application of steam of the proper temperature to the hides and skins, instead of water, acids, or other materials.

For the purpose of softening dried sheep skins, for pulling the wool and tanning the skins, a room should be provided large enough to contain, suspended, as hereafter described, as many skins as it may be required to operate upon at one time, and made as nearly air-tight as it can be without much expense, say by tight boarding and shingling; with several small windows, or openings, with shutters, to admit or exclude the air, as occasion may require. I employ racks, consisting of rails, or strips of boards, or planks placed about three feet apart, and having tenter hooks inserted about four, or five inches from each other, precisely as they are now commonly used for drying sheep skins after they are tanned. As many of these may be put up in the steam room as will consist with the objects of not having the skins touch each other, and of permitting passages through them, to hang up, and take down, the skins. The steam may be generated in any kind of boiler, and conveyed by pipes from the boiler into the steam room; it is most advantageously discharged only a few inches from the floor, in the centre of the room. For a room about 12 by 15 feet square, and 9 feet high, a common potash boiler, having the steam secured, and forced into the room by a tin or copper pipe, of about two inches diameter would be sufficient, although an iron boiler resembling those used for steam engines is more convenient. Two windows of about two feet square, placed opposite each other would well answer for such a room: with the temperature of blood heat, the skins in such a room would be sufficiently steamed in about three hours, unless they were much harder than usual. It is easy to ascertain, however, by going into the room, when the wool is loose, and the skins are sufficiently pliable, taking care to lose no more steam, by keeping the door open, than is necessary. The process may be somewhat expedited by raising the temperature a little higher, although I should not advise raising it above 150 degrees of Fahr. for fear of injuring the skins. The softening will be expedited by wetting the skins or hides, before hanging them up.

Hides of neat cattle, and other large animals, may be softened for tanning in the same way; the rails and tenter hooks being larger and farther apart, in proportion to the size of the skins, or hides. The time required for softening, will also be longer in proportion to the thickness and hardness of the skins, or hides. In all cases, the skins and hides should be affixed to the tenter hooks by the shanks, so as to keep them moderately stretched.

Slaughtered hogs, instead of being scalded in the usual way, for the purpose of scraping off the bristles, may, also, be more conveniently scalded by steam, in a similar way, where the business of dressing them is carried on to a large extent. The hogs may be hung up by the gambrils, only far enough apart to permit the butcher, or dresser, to work between them. Hot steam should then be rapidly thrown into the scalding room; until it rises to the temperature of about 175, or 180 degrees, and if very rapidly done, to the boiling point (although this is rather dangerous,) when the room should be immediately ventilated sufficiently to admit of the operation of dressing. In order to keep the labourers employed, there may be two steam rooms, so that they may operate in one room while the preparation of the hogs, and the scalding, is going on in the other.

What I claim as my invention, and desire to secure by Letters Patent, is the application of steam, instead of water, or other substances, to hides

and skins, for the purpose of softening such as are dried, and of removing the wool and hair from them, and to slaughtered hogs, for the purpose of removing the bristles.

BENJAMIN F. EMERY.

Specification of a patent for an improvement in the mode of constructing the Wheels of Locomotive Engines, for ascending Inclined Planes on Railroads; granted to ELISHA TOWN, *Montpelier, Washington county, Vermont, July* 31, 1837.

Be it known, that I, Elisha Town, of Montpelier, in the county of Washington, and state of Vermont, have invented a new and improved mode of constructing the wheels of locomotive engines used on Railroads, so as to ascend and descend inclined planes without the aid of any other power than that of the engine belonging thereto, to propel the same; called "Elisha Town's Improved Engine Wheel for inclined planes," and I do hereby declare that the following is a full and exact description.

The nature of my invention consists in attaching a wheel of proper dimensions, with a groove in its rim, similar to the wheels used to propel machinery by round bands, to the inside of such of the wheels of the *locomotive* that run on the rails on the level road, as the power of the engine is applied to, in propelling the engine car. At the commencement of the inclined plane, the ordinary rail stops, and another of the same shape, starts, but laid within the other, to correspond to the grooved wheels, and as the grooved wheels come on to this, it raises the other wheels from the ordinary rail, and the groove, by embracing both sides of the rail, produces sufficient friction to enable the locomotive to propel itself, and a train of cars, up the inclined plane.

The grooved wheel should be proportioned in size, and the bevil of the groove should vary in its inclination, to the steepness of the ascent to be overcome, and should be used only on the inclined plane.

It is proposed to use the ordinary kind of rolled iron rail, hardened, to run the grooved wheels on; but cast iron, or steel, of a similar shape, may be used.

For the cars, there should be a set of wheels with two bearings to each, with a flanch in the centre, between the bearings; one bearing for the bevil rail, and the other for the inclined plane.

The rails to the inclined plane must run past the ends of the horizontal rails, sufficiently far to have the wheels pass properly from one set of rails to the other.

What I claim as my invention, or improvement, and desire to secure by letters patent, is the application of grooved wheels to locomotives to enable them to propel themselves and a train of cars up an inclined plane.

ELISHA TOWN.

Specification of a patent for manufacturing White Lead, and other salts of lead; granted to HOMER HOLLAND, *Westfield, Hampden county, Massachusetts, March 13th,* 1836.

To all to whom these presents shall come, be it known, that I, Homer Hol-

land, of the town of Westfield, county of Hampden, and State of Massachusetts, have invented a new and useful improvement in the process for oxidizing metallic lead; and for making and producing carbonate of lead, or the pigment commonly known by the name of white lead, which improvement has not heretofore been known or used, and that the following is a full and exact description of said improvement, sufficient to distinguish the same from all things before known, and to enable any person skilled in the art or science of making and producing the salts, acetate and nitrate of lead, from any oxide, or the carbonate of lead, to apply and use said improvement in the making and compounding of the same.

The invention consists:

1st. In an improvement in the method of applying the conjoint action of friction, air, and water, to metallic lead, by placing fragments of this metal in revolving lead cylinders, or chambers, so as to produce a fine powder or pulpy suboxide of lead, for making or producing the commercial salts, nitrate and acetate of lead.

2nd. In combining carbonic acid, from the atmosphere, directly with this suboxide, as it is formed in the cylinder by the addition of carbonate of soda, or other alkaline carbonate, so as to produce, or make, the carbonate of lead, or the pigment known as white lead. To effect the oxidation of the lead, I put coarse shot, or other fragments of unalloyed lead, into a leaden cylinder, or chamber, about four feet in length, and three in diameter, made to revolve, horizontally, upon an axis of flanches. The leaden cylinder, or chamber, is enclosed in a strong and tight wooden case; air is admitted by perforations of the cylinder, at the ends, near the axis; soft water is put in the chamber, sufficient to cover the charge of shot or fragments. The cylinder is made to revolve eighteen or twenty times in a minute, by the application of any force, and the electro-chemical action of the friction, air and water, produces a fine, pulpy suboxide of lead which is strained out by removing a bung from the side of the cylinder, and placing therein a hollow tube, leading to a sieve, or strainer, resting in a canal, or trough, which conducts to a reservoir.

This pulpy suboxide sufficiently freed from water, is readily combined with acetic acid, this giving "sugar of lead," and, with nitric acid, producing nitrate of lead. To make carbonate of lead, the process is identical with the above-described for the suboxide, with the addition of about six or eight ounces of the carbonate of soda to each gallon of water used in the cylinder. The cylinder is revolved several hours in producing the suboxide for the salts of lead, and from twelve to sixteen previous to straining out the carbonate, or white lead, which is conducted, as above described, to a vessel armed with an agitator and washed by decantation with pure water, once or twice, to free it from alkali, when it is to be dried by any convenient means, becoming the pure carbonate, "or cream," white lead of commerce. In this process, for white lead, the use of vinegar and of acetic, or acetous acid in any shape, is avoided, and the health of manufacturers is preserved from the fumes of the volatile peracetate of lead so deadly in the ordinary process. The foregoing process I prefer; but the revolving chambers may be cylindrical, square, or polygonal, of any size and length. The lead lining of a wooden cylinder may be of sheet lead, or cast in cylinders to fit the wooden case, or carcass, and the cylinders are to be renewed from time to time, as they frit away. The number of cylinders, their weight, and the charge, will depend on the force employed, and the extent of the manufacture. Each cylinder (principally the lead chambers) may

weigh six hundred pounds. The charge added, from one hundred to one hundred and fifty pounds of fragments, and the necessary water and carbonate of soda. The lead fragments may be shreds of sheet lead, shot, or fragments produced by pouring melted lead through a colander into water. Antimony and other alloys of metals are often mingled with lead in the shot of commerce, and unfit them for this process. The alkali preferred is soda, as this has the strongest affinity, or attraction, for oxygen and carbonic acid, and is less liable to form an hydrate. The pulpy suboxide may also be conveniently carbonated in the vessel employed for decantation, as it is armed with agitators, by passing into the pulpy suboxide, as it is withdrawn from the cylinders, carbonic acid produced by the combustion of charcoal, from fermentation, or from the decomposition of carbonate of lime, or chalk, by sulphuric, or hydrochloric acid. The decanting vessel, again, may be used conveniently in removing a disagreeable yellowness from pure carbonated lead by minutely mingling a trifle of indigo, or blue smalts, with the carbonate of lead. I claim as my invention and improvement,

1st. The application of the revolving cylinders, or chambers, as above described, to the fritting, comminution, amalgamation, or converting of metallic lead into the fine, pulpy suboxide of lead, for the salts, acetate and nitrate of lead, or carbonate of lead.

2nd. The carbonating of the above described suboxide, as it is formed in the cylinder, by the addition of an alkaline carbonate, or by passing into this pulp directly, carbonic acid, giving immediately white lead.

HOMER HOLLAND.

Progress of Practical and Theoretical Mechanics and Chemistry.

NOTICES FROM THE FRENCH JOURNALS. TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE, BY J. GRISCOM.

New observations on Magnesian Hydraulic Lime. By M. VICAT. (Academy of Sciences, Jan. 16, 1837.)

M. Berthier has excited some doubts with respect to the chemical fact, which I recently communicated to the Academy,—namely, whether magnesia, when it occurs in the proportions of thirty or forty parts, can render hydraulic, forty parts of very pure lime.

Through deference to the opinion of this learned chemist, I have verified afresh the synthesis which served as the basis of my conclusion; and, in order to remove the possible causes of error, I desired the chief Engineer of mines, Gueymard, (in whose laboratory I was operating) to select and verify himself the carbonates of lime and magnesia, destined for the experiment.

He consequently placed at my disposal—1st. white marble from Val-Senestre, (Isère) which, in 100 parts contained;

Silica,	0.068	
Carbonate of Magnesia,	0.020	100
Carbonate of lime,	99.912	

2nd. Some Carbonate of magnesia of the shops which contained;

Magnesia,	46.00	
Carbonic acid,	51.60	100
Water,	2.40	

The silica in the lime stone from Val-Senestre, does not amount, as we perceive to $\frac{1}{1000}$, and is therefore an insignificant ingredient.

Having calcined several fragments of the limestone, until the carbonic

acid was almost completely expelled, I obtained lime, pure, within a thousandth at least, and I weighed 44 parts of it. I weighed also 80 parts of carbonate of magnesia, representing 36.80 of anhydrous magnesia. The lime was slaked into a cream, and mixed with the magnesia previously pulverized and passed through a silk sieve. After long trituration, the mixture, still too liquid to be managed, was partially dried, then divided into small balls, and placed in the muffle of a cupelling furnace, where it was exposed during four hours to a red heat.

The factitious lime thus obtained promptly dissolved with active effervescence in water. Reduced to a paste of good consistence, and placed in the bottom of a vessel and covered with water, it set in the course of a week, and on the 9th day the wet surface bore, without depression, a common knitting needle loaded with 300 grammes, (=10 oz.)

This second experiment therefore fully confirms the previous results, and solves the doubts of the honorable Academician alluded to. It explains satisfactorily the hydraulic character of the natural limestones of Sardin, (Dordogne) whose composition, taking the mean, is

Silica,	5.00
Alumine,	2.00
Oxide of iron,	0.40
Carbonate of Magnesia,	42.00
Carbonate of lime,	50.60
	100.00

In fact, if magnesia served merely as an inert material, like fine sand, for example, the lime of Sardin, containing pure lime and silica in the proportion of 100: 10 would be only half hydraulic,—whereas its well established qualities place it in the rank of good common hydraulic lime. The large quantity of magnesia which it contains, thus evidently supplies what it was wanting in silex.

In granting the accuracy of our results, M. Berthier, however, pretends that the principle is of no consequence in practice;—but there is perhaps a little too much haste in the desire to set bounds to the useful application of this or that principle; for, if I am correctly informed, the publication of my first note would have had some effect in recalling the attention of builders to the dolomites which have been rejected in various places, because, giving up to the acids only five or six hundredths of the argillaceous residue they despaired of obtaining from them a lime sufficiently hydraulic.

Mr. Dumas recollected:—that Mr. Fuchs had published a few years ago, in Bavaria some observations tending to prove that magnesia had a useful action in hydraulic mortars. He endeavoured especially to point out the great advantage that might be obtained by using dolomite, and he proved that with a puzzolana which produced only a very moderate effect when used with fat lime, mortar of an excellent quality was obtained in combination with magnesian lime.

Jour. des Mines, 3liv. de 1837.

Fossil Bones.

Among the fossil bones discovered on the borders of the Jamma, in India, some are of a blackish brown, shining, brittle, and having a conchoidal fracture. Spec. grav. 415, and their composition proves to be,

Phosphate, and carbonate of lime,	.175
Red oxide of iron	.765
Water,	.060
	1.000

The bones found on the Jamma, belong to elephants, hippopotami, Deer, Antelopes, Cattle, Horses, Hogs, Water Rats, Saurians, and others much resembling Camelopards. Idem.

On the Carbonate of Magnesia of Southern India. By M. PRINSE, (Asiat. Jour.)

This mineral which is found at Salem, is met with in veins of limited extent, from one inch to a foot in thickness, and sometimes also in beds. It snaps when applied to the tongue. Sp. gr. from 2.87 to 2.887. It is a pure neutral, anhydrous carbonate. When calcined, and water is poured on the magnesia, the latter absorbs about $\frac{1}{10}$ of its weight of the liquid with a disengagement of heat, and the water does not escape by the action of sulphuric acid in a vacuum. Idem.

Analyses of two Vegetable Soils in the vicinity of Puiseaux, department of Loiret. By M. P. BERTHIER.

1*st. Soil eminently adapted to the cultivation of Saffron.*—Large quantities of this plant have been grown around the town of Puiseaux, from time immemorial. It is not, however, every part of the country, that is fit for its culture;—only land of the best quality is devoted to it. The specimen subjected to analysis was taken from a field reputed to be excellent.

The soil is of a blond, verging upon a brown colour. By sifting and levigation only 15 per cent. of stony matters, in general very small, were separated, rarely of the size of a pea. These grains are fragments of freshwater limestone mingled with quartz. I found in the native soil:

Carbonate of lime,	.370
Silex and quartzose sand,	.454
Alumine,	.093
Oxide of iron,	.020
Water and organic matter,	.063
	1.000

Agreeably to the ordinary composition of clay, there is reason to believe that it amounts in this soil to 30 per cent. including .247 of quartzose sand; but this sand is so fine, it is absolutely impossible to separate it by levigation.

When the soil of Puiseaux is moistened, it absorbs much water, and becomes a viscid paste, which loses its consistency by drying. It is very permeable to roots, on account of the great proportion of sand and grains of calcareous matters which it contains.

2nd. The second soil was taken from the park Gauthier, which has hitherto been kept in wood. It is of a blond colour. It forms a pasty mass with water, which when dry contracts and splits, and the pieces assume the

consistency of crude pottery: yet, by calcination, it acquires very little solidity. The analysis of this soil gave.—

Carbonate of lime,	.010
Silex of quartzose sand,	.785
Alumine,	.110
Oxide of iron,	.030
Water and organic matter,	.065
	1.000

This soil must contain about 33 per cent. of clay and consequently .565 of quartzose sand.

The analysis shows that the soil of park Gauthier, has very nearly the same composition as the non-calcareous portion of the Saffron soil, and that it might be improved by adding half its weight of limestone earth in powder. Idem.

Analysis of a vegetable soil from Cuba. By M. P. Berthier.

This soil was sent to the laboratory by M. Mollien, consul general of France, at Havanna. It is that in which sugar, coffee and tobacco are raised with so much success. It is red, resembling an earthy ferruginous mineral. It is in small agglomerated masses, but is very easily crushed. No stony matters are discoverable, but vegetable remains are conspicuous, apparently proceeding from sugar cane. It exhales a disagreeable odour, analogous to sheep dung. It forms a paste with water, which contracts on drying, without splitting, and acquires much tenacity. It would form an excellent material for red antique pottery.

By levigating and sifting, only two per cent. are separated of white calcareous fragments, and vegetable fibres. Dried at the boiling heat it loses .99 of hygroscopic water. It contains:

Carbonate of lime,	.080	
Peroxide of iron,	.140	
Oxide of manganese	.010	
Silica	.336	clay .506
Alumine	.170	
Water and organic matter	.250	
	9.86	

The organic matters are equivalent to .04 of carbon.

This soil must retain water very firmly, and also acquire great stiffness, or hardness, in drying by the sun, and it is difficult to conceive how the roots of plants can get through it. Idem.

Analysis of the Sulphate of Iron of Nordhausen. By M. P. Berthier.

This salt is that from which the smoking sulphuric acid of Nordhausen is made. It is in amorphous pieces, has a granular fracture, white inside, and of a sulphur yellow on the outside. It dissolves wholly in water, and forms a colourless solution. Heated to dull redness in a platina crucible it undergoes semi-fusion, and loses at least .35 of water without disengaging any sulphurous, or sulphuric, acid. It is composed of

Peroxide of iron	.165
Protoxide of iron	.085
Sulphuric acid	.344
Water	.406
	1.000

It is a mixture of the sulphate of the protoxide and the sulphate of the peroxide of iron, both neutral. It results probably from the evaporation of the solution of sulphate of iron which has remained a long time exposed to the air.

This salt was sent as having been calcined in a reverberatory furnace; but the great quantity of water it contained, gives reason to believe it was only dried in pans. Ibid.

Analysis of a substance employed in colouring Porcelain purple. By M. Malagutti.

The English potters ornament their beautiful ware with designs printed in a very agreeable purple red, which they call pink colour. I found this material composed of

Stannic acid	.780
Lime	.150
Silica	.030 to .040
Alumine	.020
Oxide of chrome	.005
Chromate of lime, or potash	.003
	.988

In combining, by strong calcination, 100 of stannic acid, 34 of chalk, 1 to 1½ of Oxide of chrome, or 3 to 4 of crystalized chromate of potash, we obtain a colour very similar. We may add, if we wish, 5 of silica and 1 of alumine. The mass is of a dirty red; but it becomes a beautiful rose after it has been washed with water weakly acidulated by muriatic acid.

The experiments that I have made have proved, 1st, that stannic acid is coloured by chromate of potash or by the oxide of chrome at a red heat only when lime is added; 2d, that silex and alumine, without being indispensable, enhance the colour and turn it to a violet; 3d, and that the more cime and chromate of potash or oxide of chrome we add, the deeper the colour becomes, and that it may gradually attain to a chesnut brown.

If we heat to 150° C. (= 300° F.) a mixture of 100 parts of stannic acid and 2 of oxide of chrome, we have a compound consisting of small vitreous grains of a superb lilac colour. This compound which I call *mineral lac*, resists every decomposing agent, and may be applied, not only to the colouring of paper hangings, and to pottery, but also to oil painting as a subititute for the vegetable lac which painters are obliged to use to obtain a similar colour.

The question of determining the precise condition of the chrome in the plnk colour, and in the mineral lac, is a difficult one to solve. Nevertheless every thing induces me to believe it to be in the state of an oxide, and not in that of acid, in the preparation of pink colour.

The presence of lime makes up for the temperature to which we have recourse in the fabrication of mineral lac, to determine the combination of the oxide of chrome with stannic acid.

The principal considerations on which I found my opinion are the following; 1st, many of the salts of chrome are violet; chrome alum, melted in its water of crystalization, is green, but it becomes lilac if we heat it slightly red; 2d, the oxide of chrome, heated in vacuo with stannic acid and lime, gives a pink colour; 3d, stannic acid, which can be feebly coloured by the oxide of chrome at a clear red heat, is inattackable by muriatic acid, whilst pink colour, after it has been washed with acidulated water, is attacked by that acid, so that it dissolves the whole of the lime, almost the whole of the oxide of chrome, and such a proportion of the stannic acid, that it contains a neutral stannate of lime; 4th, when we calcine lime with the oxide of chrome in contact with air, chromate of lime is formed, and a combination of that earth and of the oxide of chrome, soluble in weak acids, from which it is precipitated by alkalies in the cold. Idem.

Analysis of a double Phosphate of Lead and Lime. By M. BARUEL.

This mineral was discovered in the mine of Nussiere, near Beaujeu, by M. Danhauser. It is sometimes in crystals, which are very obtuse rhombohedrons, almost lenticular, sometimes mamellated. Its fracture is somewhat splintery; its lustre is greasy and faint; its colour yellow, greenish, or grayish; its powder of a yellowish white. Its density is 5.0415. It rests on hyaline quartz. I have found the mamelonaceous variety to be composed of

Quartz	.0720	
Chloride of lead	.0765	Oxygen.
Oxide of lead	.4650	.0330
Lime	.1230	.0345
Protoxide of iron	.0244	.0055
Phosphoric acid	.1980	.1110
Arsenic acid	.0406	.0141
	.9995	

From these data it must be considered as formed of

Mixed quartz		.0720	
Chloride of lead	(Cl. Pb)	.0765	1 atom.
Phosphate of lead	$(\dddot{P}\ \dot{Pb}^3)$	.5640	7
Phosphate of lime	$(\dddot{P}\ \dot{Ca}^3)$	.2220	7
Arseniate of iron	$(\dddot{As}\ \dot{Fe}^2)$	.0650	2

Idem.

On a large and very sensible Thermoscope Galvanometer. By JOHN LOCKE, M. D. *Professor of Chemistry in the Medical College of Ohio.*

The chief novelty of the instrument which I am about to describe, consists in its proportions and the resultant effects. The object which I proposed in its invention was to construct a thermoscope so large that its indications might be conspicuously seen, on the lecture table, by a numerous assembly, and at the same time so delicate as to show extremely small changes of temperature. How far I have succeeded will in some measure appear by a very popular, though not the most interesting experiment which may be performed with it. By means of the warmth of the finger

applied to a single pair of bismuth and copper disks, there is transmitted a sufficient quantity of electricity to keep an eleven-inch needle, weighing an ounce and a half, in a continued revolution, the connexions and reversals being properly made at every half turn.

The greater part of this effect is due to the *massiveness* of the coil, which is made of a copper fillet about fifty feet long, one-fourth of an inch wide, and one-eighth of an inch thick, weighing between four and five pounds. This coil is not made in a pile at the diameter of the circle in which the needle is to revolve, but is spread out, the several turns lying side by side, and covering almost the whole of that circle above and below. The best idea may be formed of the coil by the manner in which it is actually modeled by the workman. It is wound closely and in parallel turns on a circular piece of board eleven and a half inches in diameter and half an inch in thickness, covering the whole of it except two small opposite segments, of about 90 degrees each. The board being extracted leaves a cavity of its own shape to be occupied by the needle.

The copper fillet is not covered by silk, or otherwise coated for insulation, but the several turns of it are separated at their ends, by veneers of wood, just so far as to prevent contact throughout. In the spreading out and compression of the coil it is similar to Melloni's elegant apparatus, though in my isolated situation in the interior of America, I was not acquainted with the structure adopted in his prior invention. In the *massiveness* of the coil my instrument is perhaps peculiar, and by this means it affords a free passage to currents of the most feeble intensity, enabling them to deflect a very heavy needle. The coil is supported on a wooden ring furnished with brass feet and leveling screws, and surrounded by a brass hoop with a flat glass top or cover, in the centre of which is inserted a brass tube for the suspension of the needle by a cocoon filament. The needle is the double astatic one of Nobili, each part being about eleven inches long, one-fourth wide, and one-fortieth in thickness. The lower part plays within the coil and the upper one above it, and the thin white dial placed upon it, thus performing the office of a conspicuous index underneath the glass.

I have not yet made any very extensive experiments with this instrument, being only just now prepared to do so. It is very sensible to a *single* pair of thermo-electric metals, to the action of which it seems peculiarly adapted; but the efficiency of such metals is increased by a repetition of the pairs, as in the thermo-pile of M. Melloni, especially if they be massive in proportion to the coil itself. With a battery of five pairs of bismuth and antimony, the needle was sensibly moved by the radiation from a person at the distance of twelve feet, without a reflector, the air being at the temperature of 72°.

In a recent interview with M. Melloni, to whose politeness I am much indebted, he expressed his opinion that with a thermo-pile massive in proportion to the coil, my galvanometer might be made to exhibit his thermo-experiments advantageously to a large class. Some idea may be formed of its fitness for this purpose from the result of a single trial on transmission. The heat from a small lamp with a reflector, at the distance of five feet, passed through a plate of alum, and falling on a battery or pile of five pairs of bismuth and antimony, deflected the needle only a fraction of one degree, but on substituting a similar plate

of common salt, the same heat produced, by impulse, an immediate deflection of 53 degrees.

Although the instrument is finely adapted by its size for the purpose for which it was intended, class illustration, yet from the weight of the needle and the difficulty of bringing it to rest after it once acquires motion, it is not so suitable for experiments of research as the Mellonian galvanometer. When a massive thermo-pile, such as has lately been made by Messrs. Watkins and Hill of Charing-cross, is connected with the coil and excited by a heat of about 200°, the needle being withdrawn a distinct spark is obtained on interrupting the circuit; in producing this effect it is less efficient however than the ribbon coil of Prof. Henry. The tube for suspension, placed over the centre of the instrument, is so constructed as to admit of being turned round by means of an index, which extends from it horizontally over the glass cover, and thus any degree of torsion may be given to the suspending filament or wire. A wire of any desired thickness may be easily substituted for the cocoon filament, when the instrument becomes adapted to measuring the deflecting forces of the galvanic battery. By using a thick wire it was ascertained that the calorimotor of Professor Hare, having forty plates, each eighteen inches square, acted on the needle with a force equal to ninety-two grains, applied at the distance of six inches from the centre. In attempting to force the needle by torsion into a line parallel to the coil, where the deflecting current acts with the greatest strength, I accidentally carried it too far and reversed its *position*, when instantly it became reversed in *polarity*, that which had been the north pole becoming south. This showed how unfit is the magnetic needle to measure such a quantity of electricity as was then flowing through the massive conductor. The instrument is well adapted to show to a class the experiments upon radiant heat with Pictet's conjugate reflectors, in which the differential, or air, thermometer affords, to spectators at a distance, but an unsatisfactory indication. For this purpose, the electrical element necessary is merely a disk of bismuth as large as a shilling, soldered to a corresponding one of copper, blackened, and erected in the focus of the reflector, while conductors pass from each disk to the poles of the galvanometer. With this arrangement the heat of a non-luminous ball at the distance of twelve feet will impel the needle nearly 180°, and if the connexions and reversals are properly made will keep it in a continued revolution.

I have thus given you a brief sketch of an instrument which seems to supply a desideratum on the lecture-table, when the common thermometer is too small to afford to a class that direct and full satisfaction which, in a subject so important as that of heat, is very desirable to every professor. I have not, so far, attempted to use it extensively as an instrument of research, yet it shows evidently the importance of massiveness in conductors for feeble currents, such as those produced by thermo-combinations; nor am I certain that I have arrived at a maximum in this particular, for so far as I have proceeded in using thicker conductors for the coil, the deflecting effects have been increased.

I am, &c.

JOHN LOCKE.

London, Aug. 30, 1837.

Description of the Borax Lagoons of Tuscany.

The borax lagoons of Tuscany are entitled to a detailed description. They are unique in Europe, if not in the world; and their produce has become an article of equal importance to Great Britain, as an import, and to Tuscany, as an export. They are spread over a surface of about thirty miles, and exhibit, from the distance, columns of vapour, more or less according to the season of the year and state of the weather, which rise in large volumes amongst the recesses of the mountains. As you approach the lagoons, the earth appears to pour out boiling water as from volcanoes of various sizes, in a variety of soil, but principally of chalk and sand. The heat in the immediate adjacency is intolerable, and you are drenched by the vapour which impregnates the atmosphere with a strong and somewhat sulphurous smell. The whole scene is one of terrible violence and confusion—the noisy outbreak of the boiling element—the rugged and agitated surface—the volumes of vapour—the impregnated atmosphere—the rush of waters among bleak and solitary mountains. The ground, which burns and shakes beneath your feet, is covered with beautiful crystalizations of sulphur and other minerals. The character beneath the surface at Mount Cerbole is that of a black marl streaked with chalk, giving it at a short distance the appearance of variegated marble. Formerly the place was regarded by the peasants as the entrance to hell, a superstition derived, no doubt, from very ancient times; for the principal lagoons and the neighboring volcano still bear the name of Monte Cerbole. *(Mons Cerberi.)* The peasantry never passed by the spot without turning their heads and praying for the protection of the virgin. The borax lagoons have been brought into their present profitable action within a very few years; scattered over an immense district, they have become the property of an active individual, M. Larderel, to whom they are a source of wealth, more valuable, perhaps, and certainly less capricious than any mine of silver that Mexico or Peru possesses. The process of manufacture is simple, and is effected by those instruments which the neighbourhood itself presents. In these spots artificial lagoons are formed by the introduction of the mountain streams. The hot vapour keeps the water continually in boiling ebullition, and after it has received its impregnation during twenty-four hours at the most elevated lagoon, the contents are allowed to descend to the second lagoon, where a second impregnation takes place, and then to the third, and so forth, till it reaches the lowest receptacle, and having thus passed through from six to eight lagoons, it has reached one half per cent. of the boracic acid. It is then transferred to the reservoirs, from whence, after a few hours rest it is conveyed to the evaporating pans, where the hot vapour concentrates the strength of the acid, by passing under shallow leaden vessels, from the boiling fountains above, which it quits at a heat of eighty degrees of Réaumur, and is discharged at a heat of sixty degrees. There are from ten to twenty pans, in each of which the concentration becomes greater at every descent, till it passes to the crystallizing vessels, from whence it is carried to the drying-rooms, when, after two or three hours, it becomes ready to pack for exportation. The number of establishments is nine. The whole amount produced varies from 7000lbs. to 8000lbs. (of twelve oz.) per day. The produce does not appear susceptible of

much extension, as the whole of the water is turned to account. The atmosphere has, however, some influence on the result. In bright and clear weather, whether in winter or summer, the vapours are less dense but the depositions of boracic acid in the lagoons are greater. Increased vapours indicate unfavourable change of weather, and the lagoons are infallible barometers to the neighbourhood, even at a great distance, serving to regulate the proceedings of the peasantry in their agricultural pursuits. It had been long supposed that the boracic acid was not to be found in the vapours of the lagoon; and when it is seen how small the proportion of acid must originally be, it will not be wondered at that its existence should have escaped attention. In the lowest of the lagoons, after five, six, and in some cases a greater number of impregnations, the quantity of boracic acid given out does not exceed one half per cent.; thus, if the produce be estimated at 7500lbs. per day, the quantity of saturated water daily discharged is 1,500,000lbs. Tuscan or 500 tons of English.

The lagoons are ordinarily excavated by the mountaineers of Lombardy, who emigrate into Tuscany during the winter season, when their native Appenines are covered with snow. They gain about one Tuscan lira per day. But the works are conducted, when in operation, by natives, all married, and who occupy houses attached to the evaporating pans. They wear a common uniform, and their health is generally good. A great improvement in the cultivation, and a great increase in the value of the neighboring soil, has naturally followed the introduction of the manufacture of the boracic acid. A rise of wages has accompanied the new demand for labour; much land has been brought into cultivation by new directions given to the streams of smaller rivers. Before the boracic lakes were turned to profitable account, their fetid smell, their frightful appearance, agitating the earth around them by ceaseless explosions of boiling water, and not less the terrors with which superstition invested them, made the lagoons themselves to be regarded as public nuisances, and gave to the surrounding country a character which alienated all attempts at improvement. Nor were the lagoons without real and positive dangers, for the loss of life was certain where man or beast had the misfortune to fall into any of those boiling baths. Cases frequently occurred in which cattle perished; and one chemist, of considerable eminence, met with a horrible death by being precipitated into one of the lagoons. Legs were not unfrequently lost by a false step into the smaller pit *(patizze)* where before the foot could be withdrawn, the flesh would be separated from the bone.

Min. Jour.

Description of Mr. Henry Guy's method of giving a true spherical figure to balls of metal, glass, agate, or other hard substance. Communicated by Bryan Donkin, Esq., V. P. Inst. C. E.

The method adopted by Mr. Guy, consists simply in applying to practice the principle, that if a ball can be made to revolve rapidly in every possible direction, or in other words, if during such revolution its axis of rotation be constantly changing its angular position within the ball itself, whilst a grinding tool is applied to the surface of the ball, the most prominent parts of that surface will be first acted on by the grinder, and by continuing the operation the whole of the high

er parts of the surface will be progressively ground off, and the ball will ultimately be left of a perfect spherical shape. Mr. Guy effects this by placing the ball betwixt the faces of two wooden chucks fixed to two lathe mandrels, such as are used in common turning lathes with their axes exactly in a line with each other. A quick motion is given to the mandrels in the usual way by two bands, so applied that the mandrels are placed in opposite directions; the ball, being compressed betwixt the chucks; turns, notwithstanding the friction of the tool. The tool is a bar of brass or iron, with a conical hole near one end, the larger diameter of which is made a little larger than the diameter of the ball.

Jour. of Arts and Sciences.

Whishaw's Hydraulic Telegraph.

We have long ago heard it suggested, and we think by Mr. Vallance, that a column of water could be conveniently employed to transmit information. Mr. Francis Whishaw has conveyed a column of water through sixty yards of pipe in the most convoluted form, and the two ends of the column being on a level, motion is no sooner given to one end than it is communicated through the whole sixty yards to the other end of the column. No preceptible interval elapses between the time of impressing motion on one end of the column and of communicating it to the other. To each end of a column he attaches a float board with an index, and the depression of any given number of figures on one index, will be immediately followed by a corresponding rise of the float board and index at the other end. It is supposed that this simple longitudinal motion can be made to convey all kinds of information. It appears to us that the amount of information which can be conveyed by the motion in one direction only, of the water, or backward and forwards, must be limited. To make the mere motion backwards and forwards of a float board, indicated on a graduated index, convey a great number of words or letters, is the difficulty to be overcome. Mr. Whishaw has exerted his ingenuity in this way, with a promise of success, and by-and-bye, the hydraulic telegraph may supersede the semaphore and the galvanic telegraph.—*Courier.*

Lond. Mech. Mag.

Incombustible Thatch.

This is a subject which I look upon as highly important to the "rural population" of this, and every other country, where houses, barns, and other buildings are so often covered with straw or thatch.

It is announced, that a Mr. G. B. Barentin, of Leipsic, has invented a method of rendering the thatching of buildings fire-proof. Alum, as is justly observed, will render all vegetable tissues, or fibres, incombustible; that is, its application in solution will prevent their burning in a flame. Any one may prove this with a piece of sheet or old cotton handkerchief. But then the alum being soluble, the rain will wash it out, and carry off the preserving substance, perhaps the day after its application.

A sure and cheap method of rendering straw thatch incombustible, which I have experimented upon and proved, to my entire satisfaction, is to saturate the thatch once with a solution of lime in water, or with

what is commonly used as whitewash. The addition of one pound of alum to every five gallons of whitewash, will greatly improve the composition, and it will remain in the pellicle of lime which covers every straw, so as never to be washed out by the rain. I have poured a bucket of whitewash over a heap of dry furze, then kept it in the July sun until as dry as possible, and then (let any man try it) it will not burn, even aided by ten pair of bellows.

When any building is being thatched, what more easy and cheap than to keep paying the straw with such whitewash? It will also prevent corruption, and cause the thatch to last incomparably longer than that of clean straw. Of course, the solution of lime should have the addition of a little size. The lime, size, and alum will form a crust insoluble in water, protecting each straw to which it adheres. Of course, the straw next the house must be protected as well as the exterior.

I wonder how any family can sleep quietly under a roof that may be set in a blaze by a spark from a chimney, or from a pipe, or a cigar, or a flash of lightning! We almost daily hear of people being burnt out of their cottages in Ireland, by the thatch being ignited. I hope your readers will think of this preservative, try it, and promulgate its importance. I have the honour to be, Sir, your obedient servant,

FRANCIS MACERONI.

Ibid.

Progress of Physical Science.

On the Formation of Mould, by CHARLES DARWIN, Esq., F. G. S.

The author commenced by remarking on two of the most striking characters by which the superficial layer of earth, or, as it is commonly called, vegetable mould, is distinguished. These are its nearly homogeneous nature, although overlying different kinds of subsoil, and the uniform fineness of its particles. The latter fact may be well observed in any gravelly country, where, although in a ploughed field, a large proportion of the soil consists of small stones, yet in old pasture-land not a single pebble will be found within some inches of the surface. The author's attention was called to this subject by Mr. Wedgwood, of Maer Hall, in Staffordshire, who showed him several fields, some of which, a few years before, had been covered with lime, and others with burnt marl and cinders. These substances, in every case, are now buried to the depth of some inches beneath the turf. Three fields were examined with care. The first consisted of good pasture land, which had been limed, without having been ploughed, about twelve years and a half before: the turf was about half an inch thick; and two inches and a half beneath it was a layer, or row, of small aggregated lumps of the lime forming, at an equal depth, a well-marked white line. The soil beneath this was of a gravelly nature, and differed very considerably from the mould nearer the surface. About three years since cinders were likewise spread on this field. These are now buried at the depth of one inch, forming a line of black spots parallel to, and above, the white layer of lime. Some other cinders, which had been scattered in another part of the same field, were either still lying on the surface, or entangled in the roots of the grass. The second field examined was remarkable only from the cinders being now buried in a layer, nearly an inch thick,

three inches beneath the surface. This layer was in parts so continuous, that the superficial mould was only attached to the subsoil of red clay by the longer roots of the grass.

The history of the third field is more complete. Previously to fifteen years since it was waste land; but at that time it was drained, harrowed, ploughed, and well covered with burnt marl and cinders. It has not since been disturbed, and now supports a tolerably good pasture. The section here was. turf half an inch, mould two inches and a half, a layer one and a half inch thick, composed of fragments of burnt marl (conspicuous from their bright red colour, and some of considerable size, namely, one inch, by a half broad, and a quarter thick,) of cinders, and a few quartz pebbles mingled with earth; lastly, about four inches and a half beneath the surface was the original, black, peaty soil. Thus beneath a layer (nearly four inches thick) of fine particles of earth, mixed with some vegetable matter, those substances now occurred, which, fifteen years before, had been spread on the *surface*. Mr. Darwin stated that the appearance in all cases was as if the fragments had, as the farmers believe, worked themselves down. It does not, however, appear at all possible, that either the powdered lime or the fragments of burnt marl and the pebbles could sink through compact earth to some inches beneath the surface and still remain in a continuous layer. Nor is it probable that the decay of the grass, although adding to the surface some of the constituent parts of the mould, should separate, in so short a time, the fine from the coarse earth, and accumulate the former on those objects which so lately were strewed on the surface. Mr. Darwin also remarked, that near towns, in fields which did not appear to have been ploughed, he had often been surprised by finding pieces of pottery and bones some inches below the turf. In a similar manner on the mountains of Chili he had been perplexed by noticing elevated marine shells, covered by earth, in situations where rain could not have washed it on them.

The explanation of these circumstances, which occurred to Mr. Wedgwood, although it may, at first, appear triv al, the author did not doubt is the correct one, namely, that the whole is due to the digestive process, by which the common earth-worm is supported. On carefully examining between the blades of grass in the fields above described, the author found, that there was scarcely a space of two inches square without a little heap of the cylindrical castings of worms. It is well known that worms swallow earthy matter, and that having separated the serviceable portion, they eject at the mouth of their burrows, the remainder in little intestine-shaped heaps. The worm is unable to swallow coarse particles, and as it would naturally avoid pure lime, the fine earth lying beneath either the cinders and burnt marl, or the powdered lime, would, by a slow process, be removed, and thrown up to the surface. This supposition is not imaginary, for in the field in which cinders had been spread out only half a year before, Mr. Darwin actually saw the castings of the worms heaped on the smaller fragments. Nor is the agency so trivial as it, at first, might be thought; the great number of earth-worms (as every one must be aware, who has ever dug in a grass-field) making up for the insignificant quantity of work each performs.

On the above hypothesis, the great advantage of old pasture land, which farmers are always particularly averse from breaking up, is ex-

plained; for the worms must require a considerable length of time to prepare a thick stratum of mould, by thoroughly mingling the original constituent parts of the soil, as well as the manures added by man. In the peaty field, in fifteen years, about three inches and a half had been well digested. It is probable, however, that the process is continued, though at a slow rate, to a much greater depth; for as often as a worm is compelled by dry weather, or any other cause, to descend deep, it must bring to the surface, when it empties the contents of its body, a few particles of earth. The author observed, that the digestive process of animals is a geological power which acts in another sphere on a greater scale. In recent coral formations, the quantity of stone converted into the most impalpable mud, by the excavations of boring shells and of nereidous animals, is very great. Numerous large fishes (of the genus *Sparus*) likewise subsist by browsing on the living branches of coral. Mr. Darwin believes, that a large portion of the chalk of Europe was produced from coral, by the digestive action of marine animals, in the same manner as mould has been prepared by the earth-worm on disintegrated rock. The author concluded by remarking, that it is probable that every particle of earth in old pasture land has passed through the intestines of worms, and hence, that in some senses, the term "animal mould" would be more appropriate than "vegetable mould." The agriculturist in ploughing the ground follows a method strictly natural; and he only imitates in a rude manner, without being able either to bury the pebbles or to sift the fine from the coarse soil, the work which nature is daily performing by the agency of the earth-worm.*

Lond. & Edin. Philos. Mag.

Report to the Royal Geographical Society, of an expedition in the interior of Africa.

A very full meeting of members was held on Monday evening, for the purpose of hearing the report of Captain Alexander, of his late expedition in the interior of Central Africa, directed towards the north-west coast, and the Damhara country. This expedition, originating with the society, by whom the expenses were paid, with the assistance of a grant from government, was delayed some time, till the termination of the Caffre war; but in September, 1836, Captain Alexander started on his journey, from which he returned home to the Cape on the 20th

* Since the paper was read, Mr. Darwin has received from Staffordshire the two following statements:—1. In the spring of 1835 a boggy field was so thickly covered with sand that the surface appeared of a red colour; but the sand is now overlaid by three-quarters of an inch of soil. 2. About eighty years ago a field was manured with marl; and it has been since ploughed, but it is not known at what exact period. An imperfect layer of the marl now exists at a depth, very carefully measured from the surface, of twelve inches in some places, and fourteen in others, the difference corresponding to the top and hollows of the ridges or butts. It is certain that the marl was buried before the field was ploughed, because the fragments are not scattered through the soil, but constitute a layer, which is horizontal, and therefore not parallel to the undulations of the ploughed surface. No plough, moreover, could reach the marl in its present position, as the furrows in this neighbourhood are never more than eight inches in depth. In the above paper it is shown, that three inches and a half of mould had been accumulated in fifteen years; and in this case, within eighty years (that is, on the supposition, rendered probable from the agricultural state of this part of the country, that the field had never before been marled) the earthworms have covered the marl with a bed of earth averaging thirteen inches in thickness.

September, 1837. During this period, he had traversed an extent of 4000 miles, of which 2000 was by walking, 1000 by horses, and 1000 on the backs of oxen. With the exception of four or five German missionaries, the whole country was new to Europeans for the distance of upwards of 1000 miles. Although the zoology of South Africa is very well known, Mr. Ogilby has recognised in the collection of mammalia, made by the expedition, many new species; some fine new species were contained amongst the birds; and the *hortus siccus*, placed in the hands of Dr. Lindley, contained several new and interesting species of plants, the seeds of many of which had been sown in the gardens of the Horticultural Society. The paper was replete with the most interesting details relative to the journey, many of which were highly complimentary to missionary exertion in advancing the cause of Christianity and civilization, through the means of the missionaries, whose services were on many occasions highly advantageous to the expedition. The tribes visited were the Namacquas, Bushmen, and two great nations of the plain and hill of Damharas, all of whom showed a friendly spirit to the members of the expedition, and exhibited a wish for further intercourse with Europeans. The two latter are negroes, partaking of all their marked characters, and beyond them resides a nation of red men, whom, however, it was found impossible to visit, on account of a war which was raging between the Damharas. From a female belonging to the hill of Damharas, he purchased, for two cotton handkerchiefs and two strings of beads, a little boy about seven years of age, who was in a half-starved condition, and employed in hunting lizards for food; and the appearance of this singular juvenile native in the room, along with a great variety of their domestic and warlike implements, excited considerable curiosity and attention. At different periods, the expedition suffered much for want of water, of which they were, at one period, destitute for nearly three days, with the thermometer upwards of 100 degrees in the shade, and losing several of their oxen, sheep, and dogs; and at one time ran so short of food, at to be compelled to eat leather. On the coast, they also discovered several points affording good accommodation for vessels, and through which, a beneficial intercourse might be carried on with the interior. Near the mouth of the Orange river, he discovered large quantities of copper ore, a sample of which had been analysed by Sir John Herschel, at the Cape, and found to contain 75 per cent. of copper, which was also easily accessible, and might either be smelted with Orange river wood, or carried up the river on rafts. The whole of this interesting statement will be published in the next number of the society's "Transactions." Mining Rev.

Geology of Bretagne.

A remarkably accurate and detailed memoir has been sent to the French Academy of Sciences, by M. Paillette, concerning the geology of the western part of the province of Bretagne. This gentleman, having held an official situation in the mines of Poullaouën and Huelgoat, has profited by the opportunities thus afforded him to a great extent, and given the most exact mineral topography of several cantons of complicated structure, with a fidelity and patience which will prove of much benefit to science. Besides the memoir, there are four excellent geological maps,

laid down with the utmost precision, and one of the conclusions to which M. Paillette has been led is, that all rocks of igneous origin have accidentally modified the sedimentary soils, according to circumstances which are unknown. The modifications produced by granite are a crystalline appearance, a development of the characteristics of talc, and the formation of garnets, staurotides; and those occasioned by porphyry are generally simple induration, sonorousness, and feldspathic injections. To this memoir M. Paillette has added a series of the most ingenious experiments, by which he wishes to prove the agency of electro-chemical phenomena in the daily formation of minerals in the different veins of Bretagne, and the Academy have requested him to continue his observations, in the full persuasion that they may lead to good results.

Mining Journal.

Singular Discovery of a Subterranean River.

A singular discovery was made in Blaen-y-nant lead mines, near Mold, Flintshire, a few days ago. The workmen at the end of one of the levels were surprised, and obliged to run for their lives, in consequence of an immense rush of water suddenly bursting in upon them. After three days the water totally disappeared; and, on cautiously proceeding to the place, they found an opening of about four inches diameter, through which the water had issued. Hearing a sound as of a heavy run of water inside, they enlarged the aperture so as to admit of their passing through, and found that it was the bed of a subterraneous river, which in all probability affords the principal supply to the far-famed St. Winifred's Well, at Holywell, from which it is distant about twelve miles. The stream being then shallow, they explored it about sixty yards down, and were astonished to find several large caverns to the right and left, from the roofs and sides of which were suspended numerous and beautiful specimens of white spar or stalactites. The company are in high spirits, these appearances being considered favourable for a large lodgment of ore.—*Shrewsbury Chronicle.*

Ibid.

Mechanism of the Motion of Glaciers.

Mr. Mallet, at the British Association, made it evident that many phenomena of these singular masses had been hitherto overlooked; and although described by many eminent observers, no solution had been given to the question of their movement but that of their weight, which he showed could have only a partial operation, as they often rest on rugged beds, and these not always of much inclination. He proposed a very ingenious explanation of their movement by means of hydrostatic pressure, arising from the fact of the lower part of the glacier being of a higher temperature than the upper: this causes a melting of the under part, and a consequent raising of the mass in a perpendicular direction to the earth's surface, while its descent was at right angles to the inclined surface: a progressive motion downwards ensues, following the law of the resolution of forces. He then spoke of certain causes of the rents and fissures in glaciers, these being often convex downwards, owing to the operation taking place in the middle part of the mass, which descends soonest, while the whole is held in its place by the upper and lower extremities: also tubular fissures are formed by blocks of stone

sinking by degrees in the glacier, owing to their higher temperature gradually melting the surrounding ice. He then alluded to the singular accumulations of detritus on the glaciers, which are locally termed *moraine*, and are formed by *éboulemens* in winter and covered by the snow. These he found to assume linear directions parallel to the axis of the glacier; and, from the regularity of their arrangements, he conceived it possible to discover the site of old glaciers from the moraine which had remained on the ground after their destruction. Analyst.

On the Floating Masses of Fucus occurring near the Cape Verd Islands.

M. Kunth lately presented to the Academy of Sciences of Paris, in the name of M. Meyen of Berlin, a specimen of the *Sargassum natans* (Fucus natans, Linn.) brought from the celebrated *Mar de Sargasso*, near the Cape Verd Islands. M. Kunth remarked, that this individual, like all the others observed by M. Meyen in these latitudes, does not present the slightest trace of a point of attachment. It was therefore never attached to rocks or to any other supporting body at any period of its growth, but must have been developed floating on the surface of the sea. The opinion generally adopted by voyagers, that these plants have been torn from their original situations by the waves, and collected by currents in the Mar de Saragasso, appears to M. Meyen to be inadmissible; and he is inclined to believe that they have been produced at the place where they are observed. The same naturalist maintains that such individuals formed at the surface of the water never exhibit fructification. Edin. New Philos. Jour.

Mechanics' Register.

Girard College for Orphans.

As this is an Institution in which mechanics have a deep interest, and one to the completion of which all must look forward with great anxiety, the following description of the main building and of the state of the works at the present time, by the able architect, Thomas U. Walter, Esq. cannot fail to be acceptable to our readers. Com. Pub.

Description of the main Building of the Girard College for Orphans.
By Thomas U. Walter, *Architect.*

The Girard College is situated about one and a half miles northwest of the centre of the City, on a tract of land containing forty-five acres; the whole of which was appropriated by Mr. Girard exclusively to the purposes of the institution.

The main building, which is the subject of this description, is composed in the Corinthian order of Grecian architecture; it covers a space of 184 by 243 feet, and consists of an *octastyle*, peripteral superstructure resting upon a basement of eight feet in height composed entirely of steps extending around the whole edifice; by which a pyramidal appearance is given to the substruction, and a means of approach to the porticoes afforded from every side. The dimensions of the stylobate (or platform on which the columns stand,) are 159 feet on the fronts by 217 feet on the flanks, and the cell, or body of the building, measures 111 feet by 169 feet 2 inches. The whole height, from the ground to the apex of the roof, is 100 feet.

The columns are thirty-four in number; the diameter of the shaft at the top of the base is six feet, and at the bottom of the capital five feet; the height of the capital is eight feet six inches, and its width, from the extreme corners of the abacus, nine feet; the whole height of the column, including capital and base, is fifty-five feet.

The entablature is sixteen feet three inches high, and the greatest projection of the cornice, from the face of the frieze, is four feet nine inches; the elevation of the pediment is twenty feet five inches, being one-ninth of the span.

The capitals of the columns are proportioned from those of the Monument of Lysicrates at Athens; they are divided in height into four courses,—the first embraces the water leaf, and consists of a single stone of seventeen inches in thickness;—the second course is also composed of a single stone, the height of which is two feet ten inches,—the annular row of acanthus leaves occupies the whole of this course;—the third division of the capital embraces the volutes and cauliculi,—this course, which is likewise two feet ten inches in height, is composed of two pieces, having the vertical joint between the cauliculi on two opposite faces;—the fourth, or upper course, being the abacus, is one foot five inches in height.

The ceiling of the portico will be formed by beams resting on the tenia, and extending from the cell of the building to the colonnade opposite to each column; the spaces between the beams will be filled in with rich lacunaria.

The corners of the building are finished with massive antæ, having bases and capitals composed upon the principles of Grecian architecture.

The flanks of the cell are pierced with windows, which are ornamented with the Greek antæ, surmounted with architraves and cornices.

The doors of entrance are in the centre of the north and south fronts; they are each sixteen feet wide in the clear by thirty-two feet high; their outside finish consists of antepagmenta, of two feet seven inches wide, the supercilium of which is surmounted with a frieze and cornice;—the cornice is supported by rich consoles, of six and a half feet in height, and the cymatium is ornamented with sculptured honeysuckles.

The exterior of the whole structure will be composed of fine white marble, slightly tinted with blue.

The vestibules, which are approached by means of the doors at each end of the building, are ornamented with marble antæ, columns, and entablature, of the Greek Ionic order, which support a vaulted ceiling, consisting of eliptical groin arches, enriched with frets, guilloches, and lucunaria; the columns, which are sixteen in number, will each be composed of a single piece of marble;—proportions of the order are from the Temple on the Illusus at Athens.

The lobbies in the second story are directly over the vestibules, and occupy the same space. The columns in this story, which are also sixteen in number, will be composed in the simplest form of Corinthian, or foliated, architecture, proportioned from those of the Tower of Andronicus Cyrrhestes at Athens; the entablature will be surmounted with groin arches, similar to those in the vestibules, the soffits of which will be enriched with lacunaria.

The stairways will all be composed of marble; they will be constructed in the four corners of the building, each occupying a space of twenty-two by twenty-six feet, extending the whole height of the edifice; these openings

will each be crowned with a pendentive parabolic dome, surmounted with a skylight of ten feet in diameter—the height of the skylight from the floor will be eighty feet.

The building is three stories in height; each of which is twenty-five feet from floor to floor: there are four rooms of fifty feet square in each story. Those of the first and second stories, are vaulted with groin arches; and those of the third story, with domes supported on pendentives, which spring from the corners of the rooms at the floor, and assume the form of a circle on the horizontal section at the height of nineteen feet. These rooms are lighted by means of skylights of sixteen feet in diameter. All the domes are terminated below the plane of the roof, and skylights are designed to project but one foot above it, so as not to interfere with the character of the architecture.

The whole building will be warmed by means of furnaces, placed in the cellar; and every apartment will be ventilated upon philosophical principles.

Report of the Present state of the Work.

The marble work of the cell of the centre building has been raised about ten feet during the past year, making its present height above the ground about sixty feet.

All the bands and ties for resisting the lateral pressure of the arches over the second story rooms, are firmly fixed in the walls, and the centres are completed, and prepared to receive the brick work—all therefore that remains to be done to complete this story, is simply the construction of these arches, and the setting of the marble in the lobbies, which will consequently be the first work of the ensuing season.

We had expected to finish all the second story arches during the past summer; but the unusual severity of the previous winter, and the backwardness of the spring, put it out of our power to advance with this part of the work so rapidly as we had anticipated. We have, however, been actively employed on other parts of the buildings; having accomplished, in the aggregate, at least one-third more during the past year, than in any previous season since the commencement of the work.

The easternmost *out building* is now under roof, and the carpenters are engaged in finishing the interior.

The out building nearest the college requires about ten feet in height of marble work to complete the exterior, the greater part of which will be wrought during the winter, so as to enable us to put this building under roof early in the ensuing season:—both of these out buildings will be completed during the present year, and may be occupied as soon as they are finished, without interfering with the rest of the work.

At the commencement of the last season, there were *four hundred and thirty thousand bricks* remaining on the ground from the previous year; since which time, there have been delivered at the works, one million five hundred and ninety thousand, making in all, two millions and twenty thousand; of which *one million five hundred and twenty thousand* have been used in the buildings, leaving about *five hundred thousand bricks* now on the ground to commence operations with in the spring.

The amount of marble work done during the past season is almost

double that of any previous year; and the character of the workmanship still merits the highest commendation.

The execution of the carving of the exterior capitals continues to give entire satisfaction.

Several of the large bases and column blocks are now in the hands of the workmen; and it is intended to continue with this part of the work during the winter, so as to enable us to proceed at the opening of the ensuing season, with the eastern portico, the two south columns of which have already been commenced.

The columns, antæ and entablature for the lobbies in the second story are in progress of execution; there are now completed, for this part of the work, ten capitals, fourteen bases, seven shafts of columns, and a considerable quantity of the architrave and antæ; the rest will be finished in the course of three or four months.

All the marble used in the buildings during the past year, amounts to 40,588 superficial feet, and there are now on the ground 12,338 feet of finished work, 2,173 feet of sawed material, and 3,950 cubic feet in the rough.

It is a source of great satisfaction to be able to state, that all our apprehensions in regard to the supply of marble are relieved, as the contractors have begun to work another quarry, which will enable us to obtain, without difficulty, all that may be required for the completion of the college, and all the buildings connected with it.

The whole amount of marble delivered during the past year, amounts to 39,722 cubic feet;—more than one hundred column blocks have already been quarried, and all that will be required for the exterior portico can be procured, if necessary, during the ensuing season.

The expenditures, from December 23, 1835, to December 31, 1836, amount to $153,949 74.

I have estimated the value of the materials and workmanship now on the ground, which have not yet been used in the building, at about $68,000, nearly all of which will be used during the present year.

I am happy to have it in my power to say, that thus far nothing has been omitted that would tend to give permanency and durability to the buildings;—the plans have been correctly executed, and the various departments of the work have all been faithfully and judiciously managed, by the gentlemen whom you have appointed over the several mechanical branches.

The propriety of commencing the two western out buildings in the spring, is a subject to which I would respectfully request your early consideration;—the foundations of these buildings may be laid, and the marble work constructed as high as the basement during the ensuing season, without interfering with the other work; I therefore venture to suggest, that arrangements be made for extending the work, so as to embrace these two buildings.

Girard College, THOMAS U. WALTER,
January 2nd. 1837. *Architect.*

Paving Streets with Wood.

At a meeting of the Marylebone Vestry, held Aug. 26, 1837, "Mr. Stead was introduced to the Vestry to state his plan for paving Oxford Street with wood. He said that the plan had been approved of by Sir

George Rennie, Mr. G. Rennie, Mr. Gibbs, Mr. Braithwaite and other engineers, and that they had expressed their surprise that it had not been adopted in London. It had been found to answer exceedingly well in St. Petersburg and New York, and possessed great advantages over the usual mode of paving, inasmuch as the cost would be less, the durability greater, and it would be unaccompanied by the noise which the present system is of necessity subjected to. The plan had been seen in operation in the Netherlands by Mr. Rennie, who highly approved of it. Mr. Stead was requested to furnish the Vestry with a written statement of his plan, which he consented to do."—(*Morn. Chron.*, Aug. 28.) It appears that this mode of paving has been tried for about a year and a half past in the Broadway, New York, and found to answer very well. The wood employed was that of the Robinia Pseùd-Acàcia, cut into hexagonal pieces, about 1 foot long and 10 inches across. Another experiment is now being made, with square pieces of pine and other woods, with boards placed under them, where the ground is not firm. —(*Newsp.*)

Architec. Mag.

We may add to this statement that Chesnut street, Philadelphia, from Fourth to Fifth street (now ycleped Bank Place) has been paved in excellent style, with polygona. G.

The Steam Ship Sea Horse.

We have been gratified with a view of, and trip on board, the beautiful and powerful steam ship *Seahorse*, which arrived here, on Wednesday, from Dundee, after a run of twenty-five hours, against a strong head wind. On going on board, the visitor is struck with the spacious deck and splendid saloon, as well as the general fittings and arrangements both for comfort and safety. But that which most strongly attracts the attention of the scientific observer, is the beautiful manner in which the engines perform their functions; indeed the motion is so perfectly smooth, that if you were not aware of the fact, you would scarcely believe that the engines were at work. The reason why these engines are superior to the generality of marine engines, is the application of Mr. Samuel Hall's patent condensers, and as many persons may not be acquainted with the nature and merits of Mr. Hall's invention, it may not be amiss to give a few particulars on this point, particularly as it bears so much on the safety of the boilers, and the wear and tear of the engines. First: the boilers are supplied with pure distilled water, which prevents the usual saline deposit and corrosion of the boiler. Second: as no deposit or incrustation can possibly take place, the transmission of heat to the water is more uniform, the boiler-plates are prevented from burning, and consequently a saving of fuel is the result. Third: as the steam is condensed through the medium of copper pipes (the steam being prevented from coming in contact with the jet of cold water, as in the common mode,) the air-pump has less work to perform, and additional power is thereby gained. Fourth: muddy salt water is entirely shut out from the interior of the engine, and an immense saving is effected in the wear and tear of the moving parts, as the valves, &c.; and from the muddy quality of the river Humber, it is an invaluable discovery for steamers connected with Hull. In conclusion we have but one regret, which is, that from the great width of the *Seahorse*, she will

not be able to enter any of the docks, being many feet wider than any of the dock locks, but trust that the dock company will not be long before they see the necessity of giving increased accommodation.—*Hull Advertiser.*

Mining Journal.

Steam Engines within the Borough of Birmingham:

By a report made to the Birmingham Philosophical Institution, October, 1836, it appears that 169 steam-engines had been erected from 1780 to that period, of which 17 had been erected in 1834, and 22 in 1835. The total horse power was equal to 2700 horses. Within the same period engines equal to 162 horses' power had become void, or removed. Of those erected and estimated in horse power, 275 were used for grinding flour; 1770 for working metals; 279 for pumping water; 87 for glass grinding; 97 for working wood; 44 for paper making and glazing; 37 for grinding clay; 61 for grinding colours and chemicals; and 50 for sundry purposes. The estimated consumption of coals is 216 tons per day; estimated number of persons employed 4000 males, and 1300 females; and the estimated amount of power hired out, equal to 450 horses. These estimates are confined to engines within the borough, and, of course, do not include the great Soho works of Bolton and Watt. Of the 1770 horse power employed in working metals, it is computed that 162 is used by iron founders, first applied in 1788; 570 in rolling copper, brass, and other metals, first applied in 1790; 150 in drawing wire, first applied in 1808; 201 in iron forges, and wrought iron mills, first applied in 1810; 74 in nail cutting, first applied in 1813; 104 in screw making, first applied in 1819; and 34 in drawing metal tubes, first applied in 1822.—*Railway Mag.*

Ibid.

Preservation of Wood from Decay.

The wood which is used in the salt mines of Hallein, in Germany, is preserved from decay by being saturated in strong brine. This discovery was made by observing, that the timber which supports the ceiling of the galleries, upon being exposed to the action of the salt earth, became harder and harder, and scarcely ever after liable to decay. From this fact it is supposed that the *bichloride of sodium* is as efficacious in preserving vegetable matter from the destroying energies of the dry-rot, as the *bichloride of mercury.* Certain it is, that the former plan is preferable, to the latter, so far as it is free from the injurious powers which the mercury presents to the workman, when the article which is so prepared is used in manufactories. The former is well worthy of trial, and if found to possess the qualities which it is presumed it contains, its economy and simplicity will place it within the reach of every individual.

Ibid.

Post Office Revenue of England.

A return prepared for the House of Lords, on motion of the Duke of Richmond:—shews that there has been a gradual increase from 1827 to 1836.

	Gross Revenue.	Net Revenue.
In 1827 the amount was	£2,278,412	£1,484,164.
1836 " " "	2,461,805	1,645,835.

Ibid.

LUNAR OCCULTATIONS FOR PHILADELPHIA, JULY 1838.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope.
☞ For direct vision add 180° ☜

Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
3	12	40	Im. A' Scorpii	,5,	17°	62°
3	14	9	Em.		325	18
7	11	8	Im. 58 ω Sagittarii	,6,	126	107
7	12	22	Em.		263	258
7	13	16	Im. 60 α Sagittarii	,5,6,	161	164
7	14	6	Em.		238	250
15	14	23	Im. ζ Arietis	,5,	163	109
15	15	5	Em.		254	199

Meteorological Observations for January, 1838.

Moon.	Days.	Therm. Sun rise.	Therm. 2 P.M.	Barometer, Sun rise.	Barometer, 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	33	42	30.13	30.30	E.	Moderate.		Cloudy—clear.
☾	2	30	35	20	20	W.	do.		Cloudy—do.
	3	34	45	10	15	S.W.	do.		Cloudy—lightly cloudy.
	4	36	55	5	6	S.	do.		Clear—do.
	5	46	62	29.85	29.80	S.	Brisk.		Partially cloudy—cloudy.
	6	39	48	30.10	30.25	W.	Moderate.		Clear—do.
	7	32	53	10	29.96	NW.S.	do.		Clear—lightly clooudy.
	8	49	38	29.74	90	SW.	do.	.05	Cloudy—rain.
♈	9	29	33	63	60	E.	do.	.03	Cloudy—drizzle.
	10	28	32	30.00	30.00	W.	do		Clear—do.
	11	17	21	23	23	NW.	do.		Clear—do.
	12	19	34	35	35	W	do.		Clear—do.
	13	29	42	25	25	W.S.	do.		Clear—do.
	14	29	46	29.93	29.93	S.	do.	.05	Partially cloudy—rain.
	15	42	43	63	77	W.	Brisk.		Partially cloudy—do. do.
	16	28	50	30.00	30.00	SW.	Moderate.		Clear—do.
	17	43	55	84	29.85	SW.S.	Brisk.		Partially cloudy—do. do.
☽	18	48	60	85	85	SW.	Moderate.		Heavy fog—lightly cloudy.
	19	48	44	50	40	SW.W.	Brisk.		Cloudy—do.
	20	23	32	30.10	30.15	W.	Moderate.		Clear—do.
	21	24	29	10	5	W.	do.		Cloudy—do.
	22	20	30	20	20	NE.E.	do.		Partially cloudy—clear.
	23	20	37	20	20	NE.	do.		Clear—do.
	24	24	43	15	20	E.S.	do.		Clear—do.
⊗	25	36	40	20	20	E.	do.		Clear—do.
	26	42	47	29.85	29.85	SW.W.	do.	.43	Rain—clear.
	27	36	38	30. 5	90	NE.SE.	do.	.42	Cloudy—rain.
	28	36	42	29-50	50	W.	Blustering.		Cloudy—flying clouds.
	29	23	28	85	80	W.	do.		Partially cloudy—do. do.
	30	16	23	30.40	30.00	W.	Moderate.		Clear—flying clouds.
	31	12	23	16	16	W.	do.		Clear—do.
	Mean	31.32	40.26	30.00	30.00			.98	

	Thermometer.	Barometer.
Maximum height during the month.	62.00 on 5th.	30.35 on 12th,
Minimum do.	12.00 on 31st.	29.40 on 19th.
Mean do.	35.78	30